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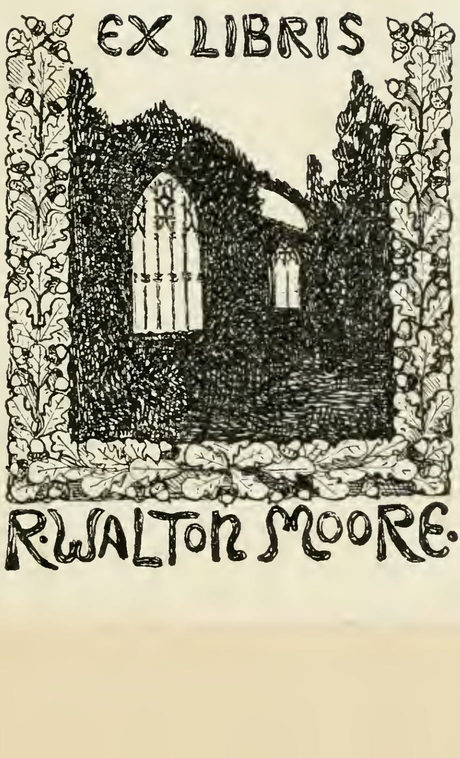
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PROCEEDINGS

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The scientific publications of the National Museum consist of two series—Proceedings and Bulletins.

The Proceedings, the first volume of which was issued in 1878, are intended primarily as a medium for the publication of original papers based on the collections of the National Museum, setting forth newly acquired facts in biology, anthropology, and geology derived therefrom, or containing descriptions of new forms and revisions of limited groups. A volume is issued annually or oftener for distribution to libraries and scientific establishments, and, in view of the importance of the more prominent disseminations of new facts, a limited edition of each paper is printed in pamphlet form in advance. The dates at which these separate papers are published are recorded in the table of contents of the volume.

The present volume is the sixtieth of this series.

The Bulletin, publication of which was begun in 1875, is a series of more elaborate papers, issued separately, and, like the Proceedings, based chiefly on the collections of the National Museum.

A quarto form of the Bulletin, known as the "Special Bulletin," has been adopted in a few instances in which a larger page was deemed indispensable.

Since 1902 the volumes of the series known as "Contributions from the National Herbarium," and containing papers relating to the botanical collections of the Museum, have been published as Bulletins.

William deC. Ravenel,
Administrative Assistant to the Secretary,
in Charge of the United States National Museum.

August 16, 1922.

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By S. A. Rohwer,

Honorary Custodian of Hymenoptera, United States National Museum.

WITH

NOTES ON HABITS AND DESCRIPTIONS OF LARVAE.

By William Middleton,

Of the Bureau of Entomology, United States Department of Agriculture.

INTRODUCTION.

The adult sawflies of the subfamily Cladiinae are, with one or two striking exceptions, rather small, black, and inconspicuous insects which attract the attention of few people other than the specialist.

The larva of most of the species are also rare and seldom seen. Two of our American species, are, however, conspicuous; one (*Trichiocampus viminalis*) because of the coloring of the adult and feeding habit of the larva, the other (*Cladius isomerus*) because the larva is the commonest defoliator of roses in the eastern states. The following paper, which is a contribution from the Branch of Forest Insects, Bureau of Entomology, contains a revision of the adults and descriptive notes for the known larvae as well as some observations on the habits of certain species. The work on the adults has been done by Mr. Rohwer and the new species should be accredited to him, while the work on the larvae was done by Mr. Middleton. The biological work and rearing was done at the Eastern Field Station of the Bureau of Entomology (Forest Insects), located at East Falls Church, Virginia.

[1] Since this paper was submitted MacGillivray has published descriptions of seven new species of North American sawflies of this group. See "New Species of Cladiinae—Hymenoptera," Ent. News, vol. 32, no. 2, 1921, p. 48–50. I have studied these descriptions but have been unable to satisfy myself that any of the forms characterized are the same as the new species described in the present paper. Because of the different interpretations of generic limits it is also impossible to be certain that the generic assignment of Dr. MacGillivray is the same as that here used, and judging from the descriptions alone it would seem that certain species placed in *Trichiocampus* would, according to the characters, here used, be placed in *Priophorus*. (See p. 4.) S. A. Rohwer.

The illustrations for the adults were prepared by Miss Eleanor Armstrong from sketches made by Mr. Rohwer, by use of a Leitz projection apparatus. The illustrations for the larvae were made by Mr. Middleton.

EXPLANATORY.

In this paper the external genitalia of the female is considered as being composed of three primary parts. The outer part is called the sheath. The inner parts, or that which has heretofore usually been loosely called the saw, are grouped together under the name ovipositor and the upper (fused dorsally) pair of pieces is termed the lance and the lower pair the lancets. In preparing the ovipository for mounting, the lancets are removed, separated from each other and from the lance and are mounted as separate parts, while the two parts of the lance are mounted as one.

The terminology used for the larva is that adopted in two recent papers [2] by the junior author.

Subfamily Cladiinae.

Cladiinae Ashmead, Can. Ent., vol. 30, 1898, p. 282 (part).
Cladiinae MacGillivray, Proc. U. S. Nat. Mus., vol. 29, 1906, p. 635 (part); Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1916 (1917), p. 108 (part).
Cladiinae Rohwer, Proc. Ent. Soc. Wash., vol. 13, 1911, p. 224.

As here treated the subfamily Cladiinae deals only with the genus *Cladius* as treated by Hartig, Thomson and Cameron, and comprises these species belonging to the subfamily Nematinae as defined by Konow,[3] in which the basal vein joins the subcosta close to the origin of the cubitus. Both Ashmead and MacGillivray in recognizing their subfamily Cladiinae placed more stress on the character of the anal cell and therefore included the genera *Platycampus* and *Anoplonyx*. According to the senior author's opinion the anal cell, although very useful in classification, is a character so subject to modifications due to the use of the wing, that it does not necessarily show subfamily relationships. He therefore prefers to use the position of the basal vein as compared to the origin of the cubitus. From the standpoint of the larvae the definition of the subfamily as here used is much more satisfactory than when the genera *Platycampus* and *Anoplonyx* are included, because the larvae of species that belong to these genera and which we have been able to study, have characters which place them in the subfamily Nematinae rather than the subfamily Cladiinae.

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[2] Middleton, William.—Suggested Homologies between Larvae and Adults in Sawflies, Proc. Ent. Soc. Wash., vol. 23, no. 8, 1921, p. 173.
Middleton, William.—LeConte's Sawfly, an enemy to young pines, Journ. Agric. Research, U. S. Dept. Agr., vol. 20, no. 10, 1921, pp. 741–760, pls. 88–92.
[3] Gen. Ins., fasc. 29, 1905, p. 45.

The three genera grouped together in this subfamily although closely allied to the Nematinae have certain characters which suggest a relationship to the genus *Monoctenus.* In venation, especially in the position of the basal vein, they are very like *Monoctenus*, The ovipositor of species of the genera *Cladius* and *Priophorus* is very similar to the ovipositor of species of the genus *Menoctenus*, while on the other hand the ovipositor of the species of the genus *Trichiocampus* is very similar to that of certain genera and species in the subfamily Nematinae. In the structure of the thorax, the adults are more closely allied to the Nematinae than to the genus *Menoctenus.* In the larva, affinity to the Nematinae is perhaps even more striking than in the adult, and there is no more to suggest relationship with *Monoctenus* in the Cladiinae than there is in the Nematinae.

The genus *Trichiocampus* as here defined is more different from both *Cladius* and *Priophorus* than these two are from each other and we believe that it will later be found advisable to express this by the use of subgenera. Such an arrangement would reduce *Priophorus* to a subgenus of *Cladius.*

Subfamily Characters, Adults.—Small or medium sized, usually black sawflies of a Nematine habitus; prepectus present although in some of the black species the prepectal furrow is indistinct; proepisternum short, not meeting ventrally; malar space present, inner margin of the eyes nearly parallel; clypeus somewhat emarginate; antennae nine-jointed; the flagellum variable; interradius wanting; three closed cubital cells (often the first intercubitus is obsolescent); basal vein joining the subcosta close to the origin of the cubitus; nervulus at or somewhat beyond the middle of the first discoidal cell; basal vein and first recurrent strongly divergent; second recurrent received by the third cubital cell; anal cell broadly contracted; discoidellan cell present, usually extending beyond the first cubitalellan cell; anellan cell longly petiolate; tarsal claws cleft with the inner tooth shorter.

Larvae.—All larvae studied have the following characters in common, and it is fair to assume that the characters given below are of subfamily value.

Antennae 4-jointed (chitinized, disk type, with central cone surrounded by flattened oval disks, outer disk may be broken into two floating or disconnected parts) (fig. 53); lacinial armature with a pair of blades or setae near galea and distinctly separate from the main series of blades or setae [4]; maxially palpi 5-jointed; labial palpi

[4] This character is found, so far as known, in only one Nematinae larva (*Pteronidea amelanchieridis* Rohwer), which clings to the surface of the leaf of *Amelanchier canadensis*, upon which it feeds, and which resembles to a considerable degree Cladiinae larvæ, although it is devoid of long, prominent hairs.

3-jointed (fig. 54); thoracic segments structurally much as Nematinae; legs 4-jointed (fig. 52); abdominal segments (uropods normal on urites 2–7, inclusive, and postpedes on urite 10 as in Nematinae) 4 annulate, A, B, C, and D (figs. 57–61), A, B, and C are large, prominent, distinct, and ornamented with spines or hairs, A to a somewhat lesser degree, while D is membraneous, inconspicuous, narrow, not prominent, unornamented, and often infolded or depressed to apparent absence; spiracle in alar region below B; spiracular area not large and distinct; alar area, below C in alar region, consisting of a pair of large dorsad-ventrad elongated folds, the anterior fold more distinct.

Distribution.—This subfamily is represented in both divisions of the Holarctic Region, but most of the species occurring in the Nearctic Region are confined to the eastern part of the continent. The best-known species of the subfamily, the bristly rose slug, *Cladius isomerus* Norton, which is very abundant and injurious in the eastern part of the Nearctic Region, and has heretofore been confused with a European species.

Generic Characters.—Heretofore with the exception of the synopsis given by MacGillivray [5] the genera assigned to this group have been separated by the modification of the flagellum, especially that of the male. MacGillivray in his recently published synopsis introduces the character of the relative length of the anterior basitarsis and separates the genus *Priophorus* from the other two genera by the absence of an appendage to the radiellan cell. Although this last-mentioned character applies for certain few species of the genus *Priophorus* some of the species described in this paper and assigned to *Priophorus* (and which agree with the definition here used) have a distinct appendage to the radiellan cell. The relative length and distinctness of this appendage is subject to individual variation and is sometimes different in the two wings of the same specimens. Because of this variability this character can not safely be used in separating genera and even for species it should be used with great care.

The secondary sexual characters, as found in the antennae and heretofore used as generic, cannot be considered of such value, since they group together species which on biology, larvae, and habitus are not closely allied. *Trichiocampus irregularis* (Dyar) has the antennæ in both sexes simple, and if those antennal characters are used it would be placed in the genus *Priophorus*, but the larvae, larval-habits, ovipositor, and leg characters show that it belongs to *Trichiocampus*, where in the female it is so closely allied to *gregarius* (Dyar) as to offer difficulty in separating it, without examination of the ovipositor. *Priophorus ulmi* (Linnaeus) has therefore been placed in the genus *Trichiocampus* because of the character of

[5] Bull. 22, Conn. Geol. and Nat. Hist. Surv., 1916 (1917), p. 108.

the male antennae, but an examination of the description of the larva, the female ovipositor, and habits as given by von Vollenhoven,[6] shows that in those characters it agrees with *Priophorus* and not with the species here assigned to *Trichiocampus*. Adults received from Enslin also show the leg and head characters of *Priophorus*. To use the character of the antenna as of generic value makes it impossible to find characters in the larvae or biology which can be used to separate species of Cladiinae into generic units. We are, therefore, of the opinion that the larvae, biology, character of the ovipositor and legs offer a satisfactory and natural means of grouping these insects and have employed them in the following synopsis:

KEY TO THE GENERA BASED ON ADULTS.

1. Anterior basitarsus distinctly shorter than the three following joints which are sharply separated from each other; supraclypeal area triangular in outline, gently convex; lower margin of the lancets nearly straight and with 12 or more regular teeth; the posterior margin of the lancet plates at most feebly armed ---------- Trichiocampus Hartig.
   Anterior basitarsus subequal with or longer than the three following joints which are not sharply differentiated; suproclypeal area rectangular in outline, strongly convex, almost keel-like; lower margin of lancets strongly curved and with eight large teeth; posterior margin of lancet plates strongly armed ---------- 2
2. Female antennae short, the third joint constricted medianly so it is strongly concave beneath; dorsal side of antennal joints 3 to 6 in male armed with rami apically, the third joint with a projection at base beneath. Cladius Rossi.
   Antennae of male and female normal, or occasionally the third joint in the male has a projection at the base beneath ---------- Triophorus Dahlbom.

KEY TO THE GENERA BASED ON LARVAE.

The following synopsis gives the most reliable and useable generic characters we have found on the larvae studied. While we have not been able to examine larvae of all of the species, it seems probable that we have had sufficient material to express confidence in the characters here used.

1. Gregarious feeders; body black spotted, sometimes subdorsally, always supraalar and epipleural regions; head mostly black (at least frons and entire dorsum from eye to eye); figures 57–59 and 71 ---------- Trichiocampus Hartig.
   Solitary feeders; body not spotted; head mostly pale (eye spots and sometimes vertex black) ---------- 2
2. Vertex and eye spots black; body usually grayish dorsally, especially in thorax from annulet A mesothorax to and including annulet C metathorax and abdominally on the eighth and ninth segments; figures 61 and 73. Priophorus Dahlbom.
   Head pale excepting black eye spots, body entirely pale; figures 60 and 62. Cladius Rossi

[6] Tijdschr. v. Ent., vol. 4, 1860, pp. 84–87.

Genus TRICHIOCAMPUS Hartig.

Trichiocampus HARTIG, Fam. Blatt-und Holzwespen, 1837, p. 176. Genotype.—(*Nematus grandis* Lepeletier) = (*Tenthredo*) *Trichiocampus viminalis* (Fallén).

The genus *Trichiocampus* was first recognized by Hartig, who treated it as a subgenus of *Cladius*, and separated it from the other groups of this genus *Claudius* by characters found in the antennae. Westwood, in 1840,[7] was the first writer to treat this group as of generic value, but he as well as his predecessors and successors defined it in much the same way as it was originally defined by Hartig.

As here defined the group is more different from the other two genera of the Cladiinae than these genera are from each other. The characters of the larvae and their gregarious habit together with the characters of the ovipositor and legs show that this group is a natural one and indicates that these characters are better than those previously used.

Generic Characters, Adults.—Clypeus emarginate; supraclypeal area gently convex, triangular in outline; lateral supraclypeal area flat; antennal foveae small for subfamily; inner margins of the eyes parallel; anterior basitarsus distinctly shorter than the three following joints (fig. 2); radiellan cell with a distinct appendage; cerci short, stout; lower margin of lancets with twelve or more regular teeth; the posterior margin of the plates of lancets not or only feebly armed; female antenna long, slender, the third joint simple in species here treated; male antenna long slender, the third joint simple or strongly produced at base beneath.

Larvae.—Characters common to the larvae studied. Head mostly black (at least frons and entire dorsum from eye to eye); frons with margin spined, median area bare; body always with black spots in supraalar and epipleural regions and sometimes spotted subdorsally. Supraalar spots extending from anterior annulet B back to about middle annulet C; epipleural spots on the posterior portion of the epipleural fold (figs. 49, 57–59). Uropods normal, on urites 2–7, urites 8 and 9 bare and urite 10 with postpedes.

Adult Specific Characters.—The color, the character of the ovipositor and the modification of the third antennal joint, in the male, offer the most valuable specific characters in this genus. The shape of the sheath and the emargination of the clypeus are also useful but more difficult to use.

KEY TO THE ADULTS.

1. Females -- 2
   Males --- 4
2. Abdomen and mesepisterum reddish-yellow; clypeus deeply emarginate. **viminalis** (Fallén).
   Body entirely black; clypeus more shallowly emarginate ------------------ 3

[7] Introduction to the Modern Classification of Insects, Synopsis, p. 54.

3. Apex of the first and all of the following joints of the hind tarsi black; clypeus with a shallow V-shaped emargination; sheath obtusely pointed apically from a broad base---------------------------irregularis (Dyar).
   Only the apical joint of the hind tarsi black (apices of some of the joints may be slightly brownish); clypeus with a shallow arcuate emargination; sheath obliquely truncate from a broad oblique base-----gregarius (Dyar).
4. Third antennal joint not produced at base beneath and not wider at the base than the pedicellum; body black--------------------------------------5
   Third antennal joint strongly produced at base beneath so it is wider than the pedicellum --6
5. Anterior margin of clypeus with a deep V-shaped emargination; apex of hind tibia and most of hind tarsus black-----------------irregularis (Dyar).
   Anterior margin of clypeus with a rather deep U-shaped emargination; hind tibia and first four tarsal joints pale-------------simplicicornis (Norton).
6. Abdomen and mesepisterum reddish yellow--------------viminalis (Fallén).
   Body entirely black------------------------------------gregarius (Dyar).

KEY TO THE LARVAE.

1. Larvae with subdorsal, as well as supraalar and epipleural rows of black body spots --gregarius (Dyar).
   Larvae without subdorsal, but with supraalar and epipleural rows of black body spots---2
2. Spiracular area not darkened----------------------------viminalis (Fallén).
   Spiracular area partially blackened by spot confluent with epipleural black spot ---irregularis (Dyar).

TRICHIOCAMPUS VIMINALIS (Fallén).

Figures 5, 9, 10, 23, 24, 36, 42, 57, 71.

Tenthredo viminalis Fallén, Svensk. Vet. Akad. Handl., vol. 29, 1808, p. 177, n. 59.

Aulacomerus lutescens Lintner, 4th Rept. Ins. N. Y., 1888, p. 44, fig. 20, 21, 22.

Trichiocampus viminalis Fallén, Dyar, 1895, Can. Ent., vol. 27, p. 340.—Cosens, Rept. Ent. Soc. Ont. 1915 (1916), p. 15.—Caesar, Rept. Ent. Soc. Ont. 1915 (1916), p. 33.—MacGillivray, Bul. 22, Conn. Geol. Nat. Hist. Survey, 1916 (1917), p. 110.

The location of the type of this species is unknown to us. American specimens have been carefully compared with European specimens identified by Konow and there seems to be no reason to doubt that this is the European species and that it was introduced before 1888, when first seen by Lintner. It is our most easily distinguished species in the Cladiinae, as it is the only one in North America in which the abdomen and mesepisternum is pale.

Female.—Length 8–9.5 mm.; length of the antenna about 5 mm. Clypeus shining with sparse, setigerous punctures, basally gently convex, the apical margin with a deep arcuate emargination which in outline is approximately the same as the outline for one of the lobes; supraclypeal foveae deep, punctiform; lateral spyraclypeal area broad, gradually sloping to the antennal foveae; ocellar basin defined with rounded walls, pentagonal in outline; middle fovea

elongate, confluent with the ocellar basin; antennal furrows nearly complete, only slightly interrupted opposite the lateral ocelli; postocellar line distinctly longer than the ocellocular line; ocellocular line subequal with the ocelloccipital line; postocellar furrow present, straight, not broken by the faint furrow that runs to the anterior ocellus; postocellar area sharply defined laterally, convex, without punctiform foveae; frontal crest broken medianly; antennae and wings as illustrated in the accompanying figures 5, 10, 23; sheath broad, straight above, oblique to a sharp apex; saw as illustrated in the accompanying figures 36 and 42. Reddish yellow; head, scape, pedicellum, mesosternum, proepisternum, pronotum medianly, meso and meta notum and apex of sheath, black; wings yellowish hyaline, strongly iridescent; venation reddish yellow.

Male.—Length 6.5–7 mm. Clypeus more densely punctured than in the female, strongly convex basally, deeply, arcuately emarginate anteriorly, the emargination in outline is approximately the same as the outline of the lobes; supraclypeal foveae deep, punctiform, the rest of the head agreeing well with the female except that the middle fovea is smaller, and more sharply defined and is in a broad depressed area; antenna as in figures 9 and 24; hypopygidium nearly truncate. Color as in female.

Described from specimens from Canada and New York.

Oviposition.—Eggs are deposited in cuts in the petiole of the leaves. Lintner has counted twenty-eight to thirty scars in one petiole.

Larva.—Length of full fed larva 16 mm. Head blackish and brownish excepting clypeus, antennae, and ventral mouthparts which are yellowish (figs. 49, 53, 54). Body yellow, large black spots in supraalar and smaller ones epipleurally (figs. 71 and 57). Annulet A pale, without prominent areas and with pairs of small hairs, usually two, situated subdorsally and in supraalar region. Annulets B and C larger than A and D and with more spines, spines grouped somewhat upon slightly prominent areas which arrange themselves in a transverse row across the tergum. Annulet D is quite small, indistinct, pale, and without spines. Epiproct with a single transverse black splotch.

Cocoon.—Length 14 mm., width 7 mm. Dark brown and translucent, papery, somewhat shining, outline irregular.

Host.—American Records:—Carolina Poplar and *Populus monilifera.* European Records:—*Populus pyramidalis* (according to Ratzeburg); *Populus monilifera* (according to Bouché); *Populus alba* and *Populus dilatata* (according to Ondemann); *Salix caprea* (according to Enslin).

Seasonal History.—Gregarious feeders, eating the entire leaf, exclusive of the midrib and larger veins. This species has apparently two generations, the first appearing in June and the second in Au-

gust. The latter generation overwintering in cocoons, the adults emerging in May of the next year.

Distribution.—This species is generally distributed over Northern and Central Europe. In America it was first discovered by Lintner at Albany, New York, where he found it defoliating *Populus monilifera*, and described it under the name *Aulacomerus lutescens*. In the summer of 1915 it was abundant enough on the shade trees at Toronto, Ontario, to attract the attention of park supervisors, and specimens were sent both to Doctor Cosens and Mr. Caesar. The same season it was abundant on poplars in Brooklyn, New York, and the Bureau of Entomology received a number of inquiries from this place. A female, reared July 28, 1915, from larvae collected June 30, 1915, on poplar at New Haven, Connecticut, has also been examined.

TRICHIOCAMPUS IRREGULARIS (Dyar).

Figures 13, 14, 26, 27, 38, 44, 59.

"N" DYAR, Can. Ent., vol. 27, 1896, p. 340.
Priophorus irregularis DYAR, Journ. N. Y. Ent. Soc., vol. 8, 1900, p. 28.
Trichiocampus irregularis Dyar, MACGILLIVRAY, Bull. 22, Conn. Geol. Nat. Hist. Surv., 1916 (1917), p. 110.

Type.—Cat. No. 21581 U.S.N.M.

Female.—Length 6 mm.; length of antenna 3.5 mm. Clypeus with rather close setigerous punctures, strongly convex in the basal middle, the apical margin with a broad, shallow, V-shaped emargination; supraclypeal foveae large, circular in outline; lateral supraclypeal area flat; ocellar basin faintly indicated ventrally and almost triangular in outline; dorsally the ocellar basin is more sharply defined and projects to the postocellar furrow; frontal crest prominent medianly and broken by the elongate middle fovea; antennal furrows wanting below lateral ocelli; postocellar furrow distinct, straight; postocellar line distinctly longer than the ocellocular line; ocellocular line slightly longer than the ocelloccipital line; postocellar area sharply defined laterally, strongly convex, without foveae; antennae as in figures 13 and 26; wings normal, stigma gradually tapering from the basal third; first intercubitus obsolescent; second cubital cell distinctly longer than the third; second recurrent received the length of the second intercubitus from the base of the second cubital; sheath straight above, obtusely pointed apically, tapering from a broad base; ovipositor as in figures 38 and 44; lancet with three broad, not emarginate, teeth at apex, then eleven prominent teeth which are pointed slightly backwards, the last two teeth are slightly larger but are not emarginate; posterior margin of transverse plates seven to ten finely serrate. Black; tibiae and the

base of the first tarsal joint white; wings fuliginous, subhyaline beyond the apex of the stigma; venation dark brown.

Male.—Length 4 mm. The description of the female applies well to the male. The hypopygidium broadly rounded apically; color same as in the female, except the antenna are pale brown beneath; antennae as in figures 14 and 27.

The above description of the female is made from specimens from East River, Connecticut. The male is redescribed from the unique type and specimens from East River, Connecticut.

Oviposition.—The eggs are deposited in a double row along the stem of a twig of the host. (Observation of Chas. R. Ely.)

Larva.—Length of full fed larva 13 mm. Head black excepting pale clypeus. Body (fig. 59) pale yellowish with large black spots in supraalar region and with black spots epipleurally which encroach, or are confluent with a spot, upon the spiracular area; spined as *Trichiocampus gregarius* and otherwise the same as that species excepting epiproct which has large, undivided, black splotch.

Cocoon.—The cocoon is translucent, pale brownish, thin walled cell, 9 mm. long by 3.5 mm. broad, irregularly oval, spun in rearing on dirt or leaves at bottom or sides of cage.

Host.—*Salix*, one, or more than one species.

Seasonal History.—Gregarious feeders. Larvae collected in late August or early September become prepupa and spin cocoons emerging as adults the following May and June, although occasionally a few come out in late September of the same year, in which they cocoon. Larvae collected in early July emerge as adults early the following September.

Distribution.—Wood's Hole, Massachusetts and Weirs, New Hampshire (Dyar); Maine, August 9, 1907; East River, Connecticut (Ely).

The type of adult came from Weirs, New Hampshire, and is Dyar's No. 9 F; the record from Wood's Hole is based on a larva which is under Dyar's No. N.

TRICHIOCAMPUS SIMPLICICORNIS (Norton).

Cladius simplicicornis NORTON, Trans. Amer. Ent. Soc., vol. 2, 1869, p. 367.
Priophorus simplicicornis (Norton) KIRBY, List Hymen. Brit. Mus., vol. 1, 1882, p. 101.—MACGILLIVRAY, Bull. 22, Conn. Geol. Nat. Hist. Surv., 1916 (1917), p. 109.

Type.—Cat. No. 10302, Acad. Nat. Sci. Philadelphia.

This species is known only from the single type male, and is closely allied to *irregularis* (Dyar) but may be distinguished by the characters given in the above key.

Male.—Length, 4.5 mm.; length of antenna, 3 mm. Anterior margin of the clypeus with a rather deep U-shaped emargination, the lobes narrow and acute; middle fovea rather large, shallow, oval

in outline, and with a tubercule in center; ocellar basin very poorly defined, especially above, hexagonal in outline; postocellar line subequal with the ocellocular line; postocellar area defined laterally by a shallow fovea, very slightly convex, with a median impressed line; antenna strongly tapering, the third joint simple and about one-fourth shorter than the fourth; stigma rather large, obliquely truncate apically, broader near base; first intercubitus wanting; second and third intercubiti subequal in length; second recurrent the length of an intercubitus beyond the second; radiellan cell completely closed, without a distinct appendage; hypopygidium rather acutely pointed. Black; knees, tibiae and tarsi yellowish, apical joint of tarsi brownish; wings smoky brown, to the end of stigma, then sub-hyaline; venation dark brown.

Redescribd from holotype.

Distribution.—Norway, Maine.

TRICHIOCAMPUS GREGARIUS (Dyar).

Figures 2, 11, 13, 25, 37, 43, 58.

Trichiocampus gregarius DYAR, Can. Ent., vol. 27, 1895, p. 191.—MACGILLIVRAY, Bull. 22, Conn. Geol. and Nat. Hist. Surv., 1916 (1917), p. 110.

Type.—Cat. No. 3481, U.S.N.M.

Female.—Length 6.5 mm.; length of antenna 4 mm. Clypeus shining with sparse, setigerous punctures, convex along the median axis, the apical margin broadly arcuately emarginate, the lobes obtuse; supraclypeal fovea punctiform; lateral supraclypeal area flat; ocellar basin practically obsolete, not extending above the anterior ocellus; frontal crest rather prominent medianly, hardly broken; middle fovea shallow, broad; postocellar line distinctly longer than the ocellocular line; ocellocular line longer than the ocelloccipital line; antennal furrows obsolete; postocellar furrow distinct, straight; postocellar area sharply defined laterally, convex and without fovea (in some specimens there is an indication of a slight median furrow); antennae as in figures 13 and 25; stigma short, two and one-third times as long as greatest width, which is at about the middle, from which it tapers sharply to the apex; first intercubitus obsolescent; second cubital cell distinctly longer than the third; second recurrent received at a distance somewhat greater than the length of the second intercubitus from the base of the second cubital; sheath straight above with a short oblique truncation apically and gradually tapering to a broad base; ovipositor as in figures 37 and 43; lancets with three broad teeth at the apex which are slightly emarginate at the middle, then ten regular teeth which are pointed backwards, then two teeth which are pointed backwards and emarginate beneath; the posterior margin of none of the transverse plates armed. Black; tibiae and tarsi

white; the apical joint of the tarsi in some specimens is brownish; wings fuliginous, subhyaline beyond the stigma; venation dark brown.

Male.—Length 5 mm. The above description of the female applies well to the male. Hypopygidium broadly rounded apically, brownish beneath; antennae as in figure 11.

Redescribed from Dyar's type and other specimens from the locations listed below.

Oviposition.—The eggs are laid in two parallel rows of slits one on each side of the petiole. They are 1.5 mm. long and placed directly opposite each other in these rows but each egg has its individual incision. The incision in deeper and the pocket fuller towards the base of the petiole and the opening only extends over the apical two-thirds of the pocket.

Larva.—Length of full fed larva 13 mm. Head above, from eye to eye, frons and apices of mandibles blackish; epicranium about frons, below antennae, epistoma, labrum, mandibles excepting apices, and ventral mouth parts, yellowish to pale brown. Body (fig. 58) pale yellow, with subdorsal, supraalar and faint epipleural black spots. Annulet A pale excepting faint subdorsal spots, without prominent areas and with only a pair of small subdorsal spines, annulets B and C large and thickly spined, the spines grouped upon slightly prominent areas arranged in a transverse row across the dorsum; annulet D bare, narrow, indistinct, pale, without spots or hairs. Epiproct with a pair of subdorsal blackish spots.

Cocoon.—The cocoon is translucent, pale brown, thin walled cell, length 10 mm., width 4 mm.: irregularly oval. Spun in rearing on dirt or leaves at bottom or sides of cage.

Pupa.—Pale, 8.5 mm. long.

Host.—*Populus deltoides* (according to material from Chas. R. Ely) and *Populus tremuloides* (according to Dyar).

Seasonal history.—Gregarious larvae feeding on more or less of the leaf tissue depending on the size of larva, the younger larvae skeletonizing while the larger leave only the principal veins. The number of generations a year has not as yet been determined; prepupae and larvae about fullgrown on July 19 became adults between August 2 and 7.

Distribution.—Keene Valley, New York (Dyar); East River. Connecticut (Ely); Northeast, Pennsylvania (Cushman).

Genus CLADIUS Rossi.

Cladius Rossi, Fauna Etrusca. ed. 2, vol. 2, 1807, p. 27. *Genotype.*—*Tenthredo difformis* Panzer.

On account of its peculiar antenna in the male and because it is represented by such common garden insects the genus *Cladius* has

long been correctly recognized and is one of the few well-known genera of the Tenthredinidae which does not have a synonym. In the larva and in the adult the genus *Cladius* is closely allied to *Priophorus.*

The genus is distributed throughout the Palearctic Region. One species has been described from the northern Oriental Region and there is one species in the Nearctic Region. The fossil *Cladius* recently described by Professor Cockerell should probably be referred to *Priophorus* (p. 36). From our present knowledge it is fair to assume that the genus *Cladius* originated in and is naturally confined to the Palearctic Region. The North American species will probably be found to be an European form and the species from northern India be found to occur only in that portion which is Palearctic.

Generic Characters, Adults.—Clypeus arcuately emarginate; antennal foveae deep, large, extending almost to the eyes; supraclypeal area strongly convex, rectangular in outline; inner margin of the eyes slightly converging below; anterior basitarsus subequal or longer than the three following joints (fig. 3); the male antenna with joints 3, 4, 5, and 6 with apical dorsal projections and with the third joint with a strong basal projection beneath; the antenna of the female short, the third joint compressed, distinctly concave beneath; radiellan cell with a distinct appendage; cerci long and slender; lower margin of lancet strongly curved and armed with eight large teeth; the posterior margin of the lancet plates strongly armed.

Larvae.—See characters in above key. Larvae of only one species available for study, and all characters for genus are taken from this species.

CLADIUS ISOMERUS Norton.

Figures 3, 7, 16, 17, 28, 29, 39, 45, 50, 60, 62–70, 72.

Tenthredo (*Cladius*) *isomera* Harris, Cat. Ins. Mass., 1835, p. 583, without description.

Cladius isomera Norton, Proc. Bost. Soc. Nat. Hist., vol. 8, 1861, p. 223; Trans. Amer. Ent. Soc., vol. 1, p. 74.—Murtfeldt, U. S D. A. Div. Ent. Bull. 22, 1890, p. 78.

Cladius pectinicornis Riley, Ins. Life, vol. 5, 1892, pp. 6–11, figs. 1 and 2.—Dyar, Can. Ent., vol. 27, 1895, p. 340; Can. Ent., vol. 28, 1896, p. 239.—Dalla Torre, Catalogus Hymenopterorum, pt. 1, 1894, p. 291.—Marlatt, U. S. D. A. Techn. Ser. 3, Bur. Ent., 1896, p. 19.—Chittenden, U. S. D. A. Bur. Ent. Circ. 105, 1908, pp. 6–9, figs. 3 and 4.

The location of the type of *isomerus* Norton is not definitely known, but it is presumed that the female bearing number 185 in the Harris collection is one of the types; all others are probably lost.

In 1892 Riley synonymized the American bristly rose slug (*isomerus*) with the common European species (*pectinicornis*) and

since then all American authors have followed this synonymy. There seemed to be no good reason for doubting that the American species was the same as the European and the writers were much surprised, when they compared American insects with literature and European specimens, to find that *isomerus* did not agree with *pectinicornis*. *Isomerus* differs from *pectinicornis* in much the same manner as does the European *difformis*, and if the American species is the same as any European species it is synonymous with *difformis*, and not *pectinicornis*, as previously supposed. The United States National Museum contains about fifteen specimens of Cladii from the Palearctic region, and while most of these agree with various species as they are characterized, some few, especially specimens from Japan, do not agree, and it seems that the understanding of the species in Europe is not yet sufficiently stabilized to make it advisable to try to synonymize our American species with any of the European. Until it is possible to carefully compare our American form with authentic European specimens of all the species we prefer to use Norton's name for our species. We have studied very many specimens, collected throughout the range of the species in America, and have observed but little variation. The absence of variation in the number of rami on the male flagellum is especially noticeable. The extent of yellow on the legs is also remarkably constant.

Female.—Length 5 to 6 mm.; length of antenna about 3 mm. Clypeus coarsely punctured, convex, the anterior margin broadly, arcuately emarginate, the lobes narrow and triangular in outline; supraclypeal foveae deep, oval in outline; lateral supraclypeal area convex near the eye, sharply sloping into the antennal foveae; ocellar basin completely wanting; frontal crest strong, broken medianly; middle foveae small, oval in outline; postocellar line nearly twice as long as the ocellocular line; ocellocular line slightly longer than the ocelloccipital line; antennal furrows wanting; postocellar furrow complete, well defined, straight, not broken by the furrow from the anterior ocellus; postocellar area sharply defined laterally, very gently convex; antenna as in figures 17 and 28; wings as in figure 7; sheath straight above, truncate apically, oblique to the broad base; ovipositor as in figures 39 and 45; cerci long, slender. Black; tibiae and tarsi white; apices of the posterior tibiae and the apical four joints of the posterior tarsi brownish; wings yellowish hyaline; venation pale brown, costa and the stigma yellowish.

Male.—Length 5 mm. The above description of the female applies very well to this sex except that the four anterior tarsi are usually brown and the costa is not so distinctly yellowish; hypopygidiun narrowly rounded; antenna as in figures 16 and 29.

Described from numerous specimens taken in the vicinity of Washington, District of Columbia.

Oviposition.—The egg is laid in an incision in the axis of the leaf. The incision is about 1.75 mm. long, enters the axis on the upper side in the middle of the fluting, is slightly deeper apically where it about reaches the center. In the living leaves these egg scars are quite readily observed as the edges of the puncture or rip have a yellow brown, dead, and frayed appearance.

Egg.—Length, 1.25 mm.; greatest width, 0.33-0.4 mm.; yellowish, translucent, soft, gelatine-like, oval, somewhat larger towards the cephalic end, thin skinned, the surface smooth to shiny.

Larva (fig. 72).—In the earlier stages the head and spines are blackish, but as the larva grows the head becomes tan in appearance and the spines white. The head when appearing tan is greenish with tan or pale brown spots (fig. 50); the eyes are in black spots and the frons is spined medianly as well as marginally. The body is pale green, very spiny, and with the elementary canal rather distinct and imparting a green hue to the translucent body. Annulet A smaller than B and C and with but four pairs of spines; annulets B and C largest and with numerous spines; and annulet D smallest, and spineless (fig. 60). The spines group themselves somewhat on rather prominent areas which are arranged in a transverse row across the segment. Legs semitransparent and 4-jointed. Uropods on urites 2–7, urite 8 bare, urite 9 with a pair of small adventral protuberances (doubtless uropods but not developed to the extent of those on urites 2–7) and urite 10 with the postpedes.

LARVAL INSTARS.

The following series of descriptions record the appearance and changes in the larvae of *Cladius isomerus* from stage to stage. A comparison of the mandibles of an early second stage larva and a full-grown larva reveal no fundamental differences. The mandibles of the mature larva being generally larger and their teeth more blunt and appearing worn, while those of the younger larva were long in proportion to their width, with the teeth sharp and fine.

STAGE I (both sexes).—Body length, 2–3 mm.; head, 0.5 mm. high by 0.4 mm. wide. Color: Body translucent white; alimentary canal greenish; legs white; spines long and black on head and body; head pale or faintly grayish; eyespots black.

STAGE II both sexes).—Body length, 2.5–4 mm.; head, 0.6 mm. high by 0.5 mm. wide. Color: Body whitish green; spines of head and body not conspicuously blackish; head pale yellowish with black eyespots.

STAGE III (both sexes).—Body length, 4.5 mm.; head, 0.75–0.8 mm. high by 0.6-0.7 mm. wide. Color: Body translucent greenish white and shiny; all spines black; body spines longer than those on

vertex of head; head pale grayish yellow, darkened across face between eyes; eyespots black.

Stage IV (both sexes).—Body length, 5.5–9 mm.; head, 1 mm. high by 0.8 mm. wide. Color: Body pale green; alimentary canal leaf green; spines blackish on head and body; head pale tan darkened across face between eyes; eye spots black.

Stage V (ultimate male from leaves).—Body length, 7–11 mm.; head, 1.2 mm. high by 1 mm. wide. Color: Body while feeding greenish; later, when feeding is completed and alimentary canal is emptied, leaden white; spines, head, and body whitish; head with brownish freckles; frons pale brownish; mouth parts brownish; eye spots black.

(Ultimate male from cocoon).—Body length, 5.5–6.5 mm. Color: Same as larva above with emptied alimentary tract.

Stage V (preultimate female).—Body length, 8–10.5 mm.; head, 1.3 mm. high by 1.1 mm. wide. Color: Body greenish white; head tan.

Stage VI (ultimate female from leaves).—Body length, 11–14 mm.; head, 1.5 mm. high by 1.3 mm. wide. Color: Body greenish white while feeding; later, when finished feeding and alimentary canal is emptied, leaden white.

(Ultimate female from cocoon just spun).—Body length, 12–13 mm. Color: Same as larva above with emptied alimentary tract.

The following table (Table I) records, stage by stage, the change in size of a series of isolated larvae:

TABLE I[8]

Subletter or individual.	Sex.	Stage (size in terms of mm.). 1			2			3			4			5			6		
		Body long.	Head high.	Head wide.	Body long.	Head high.	Head wide.	Body long.	Head high.	Head wide.	Body long.	Head high.	Head wide.	Body long.	Head high.	Head wide.	Body long.	Head high.	Head wide.
a	Female	2	0.5+	0.4—	2.5	0.6	0.5	4.5	0.8	0.7—	5.5	1	0.8	8.	1.3	1.1	12	1.5	1.3
c	Female	2+	.5+	.4—	3	.6+	.5	5	.75	.6	6	1	.8	9.5	1.3	1.1—	11	1.5	1.3—
g	Female	2	.5+	.4—	3	.6	.5	5	.75	.7—	6	1	.8	9.5	1.3—	1.1—	12	1.5	1.3—
Average	Female	2	.5+	.4—	2.8	.6	.5	4.8	.77	.67	5.8	1	.8	9	1.3	1.1—	11.7	1.5	1.3
d	Male	2	.5+	.4—	3.2	.6+	.5	4.5	.75	.6	6.5	1	.8	9.5	1.2	1	......	......	......
i	Male	2	.5+	.4—	2.75	.6	.5	4.7	.75	.6	5.5	1	.8	10	1.2+	1 +	......	......	......
j	Male	2	.5+	.4—	2.9	.6	.5	4.7	.75	.6	5.3	1	.8	7.5	1.2	1	......	......	......
k	Male	2	.5+	.4—	3	.6	.5	5	.75	.6	6	1	.85	10	1.2	1	......	......	......
Average	Male	2	.5+	.4—	3	.6	.5	4.7	.75	.6	5.8	1	.8	9.2	1.2	1	......	......	......

[8] These larvæ are of the second generation hatching from eggs laid in leaves of Rosa Conrad E. Myers (3) on a single day, and observations on them were recorded under Bureau of Entomology number Hopk. U. S. 13694b1. The notes for each larva are recorded under the subletter mentioned in the table.

Cocoon.—The cocoon is a semitransparent, whitish to pale brown, thin walled cell; 7 mm. long by 3 mm. wide, irregularly oval. It seems to consist of several layers, one complete inner envelope and two or three partial outer envelopes that serve as further protection and at the same time attach more firmly the inner case to the leaf upon which it is spun.

Pupa.—Pale yellow white, length 6 mm. (alcoholic specimen); living specimen described as grayish green; the thorax and end of body slightly yellowish; head whitish green; ocelli brown; eyes black; antennae, wing sheaths and legs white, with a slight green tinge. Darkened pupa, 6 mm. long; head and thorax black, excepting legs and wing pad, which are yellow; abdomen dark brown.

LIFE AND SEASONAL HISTORY.

The studies which furnished information on the stages likewise afforded an opportunity for observations to be made on the length of the various stages and periods. Observations of this character could hardly be made under natural conditions because the variation in emergence of overwintering adults, coupled with the difference in length of life under varying conditions, makes it but a short while before all forms of the insect, especially all stages of the larvae, may be found in the rose garden at the same time.

The following table is summary of the notes made upon the length of the various periods and stages of eleven larvae of the second generation. These larvae were under close observation during their entire life, and since comparisons indicate that the life-cycle of the preceding and succeeding generations (excepting the resting stage of the overwintering generation, which is longer) is approximately the same, the table will serve to represent the average (in days).

TABLE II.

Subletter.	Sex.	Incubation period.	Length feeding period.	Stages.				V. Ultimate male.	V. Preultimate female.	VI. Ultimate female.	Length cocoon period.	Total length life.
				I.	II.	III.	IV.					
a	Female	8	12	2	2	1	2	.....	3	2	10	30
b	*	8	.....	2	2	2	1					
c	Female	8	13	2	2	1	2	.....	2	4	9	30
d	Male	8	11	2	2	2	2	3	.....	.....	.....	.....
e	*	8	.....	2	2	1	.....	.....	.....	.....	.....	.....
f	*	8	.....	3	2	3	.....	.....	.....	.....	.....	.....
g	Female	8	12	2	2	1	2	.....	2	3	10	30
h	*	8	.....	2	2	1	.....	.....	.....	.....	.....	.....
i	Male	8	11	2	2	1	3	3	.....	.....	11	30
j	Male	8	11	2	2	1	2	4	.....	.....	11	30
k	Male	8	11	2	2	1	3	3	.....	.....	11	30

* Larva died.

Upon hatching the larva does not eat the skin of the egg but leaves it in the puncture. Besides shedding and changing its dimensions as described under "Larval Instars", the larva characterizes its advance, somewhat by a difference in the extent of its feeding. The larvae during the first two stages, skeletonize small separate splotches usually from the underside of the leaflet. Late in the second stage or early in the third the larvae begin to cut holes through the leaflets. By the fourth stage the holes are cut clear through to the margin of the leaf and some of the edge is eaten, including small veins. The fifth stage larvae feed on the entire leaf, usually stopping only for the heavy midrib and bases of the larger veins.

When full grown the larva stops feeding and crawls about searching a place suitable for cocooning, in the meantime evacuating by the usual method, its alimentary tract. During this process it changes in appearance from geenish white to a yellow or a leaden white but neither sheds nor otherwise changes in character. The cocoon is spun in the leaves, usually in a curled leaflet.

In the foregoing table, as in the description of "Larval Instars", the male and female fifth stages are made separately and the sixth stage is represented only in the female. This treatment indicates an influence of sex upon the number of larval stages which is worthy of especial mention. The male larvae have one less stage than the female. In the fifth stage of the male (which is comparable with the fifth stage of the female in size, proportions, and other characters) the male larva feeds, empties his elimentary tract, and without shedding spins his cocoon. The female larva, however, sheds to become larger, feeds again, and without shedding in this sixth stage, spins her cocoon. Thus the male larva has five instars while the female has six. Another interesting feature which was discovered in the study of this insect's development in the absence of a distinct prepupal stage. In this respect not only is the spinning stage identical in appearance with the feeding form but there is neither a shedding of the skin nor a loss of hairs between feeding and cocoon spinning, during the spinning nor after it until pupation occurs. This is a peculiarity of note especially in view of the striking changes usually exhibited in the sawflies previous to spinning. In the Nematinae, a subfamily close to and much like the Cladiinae, this prepupal stage is clearly defined. Of what significance this change from the usual method of development of sawflies is, the authors hesitate as yet to form an opinion.

The following information was obtained from notes made on a number of larvae of both the first and second generations during the period between the molting of the penultimate stage and the emergence of the adult. This period is divided into several portions;

first, the ultimate stage feeding period varying from 2 to 3 days in length and averaging 2.6 days for both males and females of both the first and second generations; second, the ultimate stage between feeding and spinning, a short time occasionally as long as a day; third, the period spent between the spinning of the cocoon and the appearance of the pupa, five and six days respectively in the two opportunities in which the appearance of this stage was noted; and fourth, the pupal period, 3 days in both instances noted. The total length of the cocoon period, or the time spent between spinning and adult emergence is shorter for the first generation, being 8–9 days in length and the sex of the individual does not seem to be associated with the variation in the length of the period, however, the second generation ranges from 10–11 days which variation is associated with the individual sex as follows: Ten days for the females and 11 days for the males.

BEHAVIOR.

The adults of this sawfly are restless in nature but more so in captivity, spending most of their time trying to escape. If jarred or disturbed while on a leaf or twig, both sexes fall to the ground, fold their legs, wings, and antennae, close their bodies and remain motionless, a common habit among sawflies.

For this reason, observations on the habits and functions were difficult to make, and at best somewhat superficial and wanting in detail and exactness. The following notes on mating and oviposition, however, were deemed worthy of publication.

Mating.—A female from one isolation cage where she was reared without access to a male and a male from another were placed in the same vial—at first they paid no attention to each other, but later the male became much agitated and when in close proximity to the female exerted his genitalia and endeavored to grasp the female with the harpes. In a few attempts he was unsuccessful, but after the first few trials the female became more submissive and remained quiet, not avoiding the male. A few seconds later a union was effected. It was very short, and with the exception of motion of apical part of abdomen the insects were motionless. On completion the female was the first to show desire to break away, and pushed her ovipositor down against the top of the abdomen of the male. When the male left the female, he remained quiet for a few seconds and again resumed his activity. No other attempt of mating was observed. The position normal for Nematinae was the one assumed.[9]

Oviposition.—The eggs of *Cladius isomerus* are laid in the midrib of the leaf from the upperside and in the middle of the fluting. Upon arriving at a favorably considered place for oviposition the

[9] The Mating Habits of Some Sawflies, S. A. Rohwer, Proc. Ent. Soc. Wash., vol. 17, 1915. pp. 195–8.

female bends the apex of her abdomen well under—exerts her ovipositor slightly from the sheath and endeavors by a posterior sliding motion to catch it in the stem tissue. Once caught she works her lancets until the slit is well under way, then she raises her abdomen, completing the exsertion of her ovipositor and exposing both the lancets and the lance to view. The lancets are worked opposite each other up and down, by a somewhat rolling (side to side) motion of the apical tergites of the abdomen, while the lance seems to act as guide, brace, and track for the moving lancets. This part of the work is continued anteriorly until the ovipositor is buried in the tissue and the sheath once again is in contact with the stem. A short period of work follows during which the ovipositor is probably withdrawn from the slit and recased in the sheath, and the egg laid. The abdomen is then swung back, its apex in contact with the stem, until the slit is passed, then it is straightened to the normal position and the female moves to the next location to be favored with an egg.

The following table records the number of eggs laid on each of several days, and the number and sex of these insects present in the cage at the time of oviposition and the result of the day's oviposition.

TABLE III.

Cage No.	Date.	Variety of rose.	Parent adults.	Parent adults generation.	Results.		
					Eggs.	Larvæ.	Adults.
	1918.						
13694 b 1..	May 22	Conrad F. Myers.	3 females, 6 males	Second....	12	11	3 females, 3 males
13694 b 2..	May 23	Frau Karl Druschki.	4 females, 5 males	...do......	....	....	
13694 b 3..	May 24	Killarney.......	3 females, 6 males	...do......	2	1	1 male.
13694 b 4..	May 25	A. R. Waddell..	2 females, 4 males	...do......	....	....	
13694 d 1..	June 22	Killarney.......	3 females, 4 males	Third.....	35	28	
13694 d 2..	June 23	General Jacqueminot.	.....do..........	...do......	19	19	
13694 d 3..	June 24	Kaiserina Augusta Victoria.	3 adults.........	...do......	....	....	

The number of eggs a female adult of the bristly rose slug can lay has not been recorded, but the abdomen of a virgin female killed four days after emergence contained 41 eggs. One of the females which died and was removed from the second cage (see Table III) was likewise dissected and 28 eggs were counted from her abdomen. It was, however, impossible to ascertain the condition of these eggs as far as the maturity was concerned owing to their poor preservation.

Egg Slit.—The eggs are laid in short slits in the fluting of the upper surface of the midrib of the leaf and early in their incubation period are concealed in the slit or pocket and covered over with a yellowish white sawdust or ovipositor-torn fiber. During the period of incubation they increase in size until the day previous to the hatch-

ing of the larvae; they are yellow green in color and so much swollen as to protrude from the slit. The puncture itself becomes more distinct, as a brownish scar, with age.

METEOROLOGICAL NOTES.

All life has its optimum conditions for growth and also its maximum and minimum requirements and limits for existence of each of the various factors that go to make up those conditions. The extreme heat and humidity of a part of the summer of 1918 gave an excellent opportunity for observing the effect of high temperatures on this species. The following account is from notes made by S. A. Rohwer.

After a maximum temperature of 105.5° and a minimum of 76° with the humidity varying from 32° to 83° and including a period of between 10 to 12 hours when the humidity was 80° or more,[10] but few larvae were found in the rose garden, and these "sicklooking" and not feeding. Three days before a large number of young and partially developed larvae were observed on these plants. Further, there was no mature feeding work done at this date, proving that the larvae had not completed development. The variation of temperature and humidity between the position occupied by the larvae and that of the hygrothermograph was considerable, the latter recording air temperature as 92° and humidity as 54° while a sling psychrometer at the former location read 99.5° temperature and 73° humidity. Later records of the same day showed 104° temperature and 40° humidity by the hygrothermograph and 106° temperature and 43° humidity by the sling psychrometer with all larvae gone.

This hot spell was of slightly over a week in duration and the summary of the temperature for the first six days as recorded by the hygrothermograph is as follows:

6.25	hours above 100°	53.0	hours below 75°
12.5	hours above 95°	9.75	hours below 70°
26.5	hours above 90°	0	hours below 63°
80.5	hours below 80°		

Following this period of excessive temperature and high humidity, *Cladius* larvae were rare and remained scarce throughout the rest of the year, whereas earlier in the season they had been quite abundant.

PHENOLOGICAL NOTES.

The seasonal phenomena of development for plants are often of much importance in indicating the appearance of or the approach of a particular stage of an insect. In the bristly rose slug, however, the

[10] Records from a hygrothermograph located a few feet from the rose garden and about 4 feet above the ground. The long period of high humidity was recorded the day before these observations.

irregularity of emergence and the overlapping of the generations reduces the value of such observations to the minimum of first appearance. Observations made during the years 1916 to 1919 indicate that in the vicinity of Washington, District of Columbia, the parent adults of the first generation of the bristly rose slug appear coincident with the full blooming of the Snowball (*Viburnum opulus* and *V. plicatum*) and the weigela (*Diervilla florida*).

HOSTS.

From observations by Mr. Rohwer, made during two seasons on the roses at the Eastern Field Station, from notes sent by correspondents, and from field studies by Mr. Rohwer and the author at Falls Church, Virginia, and many other places throughout the range of this species' distribution, it seems fair to conclude that *Cladius isomerus* will attack all cultivated varieties (and species) of rose. Varieties with a small midrib or forms with hairy leaves, while not immune, are not favorable food plants. The one essential is, however, a midrib of sufficient size to hold the eggs. Preliminary observations indicated that certain varieties seemed to be preferred but more extended study proved that the condition of the leaves was a more important factor. There are a few authentic records of the species living on the common eastern wild rose (*Rosa palutris* Marsh), but the evidence seems to indicate that where cultivated roses are present they are preferred.

The following list gives the varieties of cultivated roses on which larvae have most frequently been observed.

Climbers.—*Rosa multiflora*, Dorothy Perkins, Philadelphia Crimson Rambler, Climbing Baby Rambler.

Hybrid perpetuals.—Paul Neyron, Conrad F. Meyer, General Jacqueminot, Clio, Camille de Rohan.

Tea.—Radiance, La Tosca, Killarney, White Killarney, Frau Karl Druschki, Mrs. A. R. Waddell, Stanley, Hadley, Mrs. Aaron Ward, Kaiserin Augusta Victoria, Marquise de Querhoent, Gruss an Teplitz, Laurent Carl.

PARASITES.

Two parasites are recorded in literature as having been reared from *Cladius isomerus*. They are:

Frontina tenthredinidarum Townsend.[11]

Coelopisthoidea cladiae Gahan.[12]

Neither of these parasites are, however, sufficiently abundant to be considered as a successful means of control.

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[11] Tothill, Can. Ent., vol. 45, 1913, p. 73.

[12] Gahan, Can. Ent., vol. 45, 1913, p. 103.

Genus PRIOPHORUS Dahlbom.

Priophorus Dahlbom, Conspect. Tenthredin. Scan., 1835, p. 4. Genotype.—(*Priophorus pilicornis* Dahlbom) = (*Trenthredo*) *Priophorus padi* (Linnaeus).

Stevenia (Lepeletier MSS.) Brullé, Hist. Nat. Ins., Hymen, vol. 4, 1846, p. 667.

No species were included by name in Brullés account, but it is evident that his remarks apply to the species now known as *Priophorus* (*varines* (Lepeletier)) = *padi* (Linnaeus), so *Stevenia* is isogenotypic through synonymy with *Priophorus*.

The genus *Priophorus* was first described by Dahlbom as a subgenus of *Nematus*. Later, Hartig placed it in his genus *Cladius* and made it a subgenus of *Cladius*. Until recently it has been treated as a subgenus of *Cladius*, but Konow, Enslin, and MacGillivray considered it as of generic value. All the species known to us are closely allied to the species of the genus *Cladius*, but the larva and antenna are different, so it seems advisable to consider it as a separate group. For the time being, at least, we prefer to treat it as a genus.

Generic Characters—Adults.—Clypeus slightly emarginate; supraclypeal area strongly convex, almost keel like, rectangular in outline: lateral supraclypeal area narrow, sloping to the large antennal foveae; the inner margins of the eyes subparallel; anterior basitarsus longer than or subequal with the three following joints, which are not sharply separated from each other (fig. 4); wings about as in figure 6; radiellan cell usually without an appendage but occasionally with a short distinct appendage; cerci medium; lower margins of the lancets curved, armed with eight teeth; posterior margins of all the lancet plates heavily armed; female antenna long, slender, the third joint simple; male antenna long, slender, the third joint usually simple but occasionally with a strong projection at the base beneath.

Larvae.—Characters common to the larvae of this genus studied; Head (figs. 51, 55, 56) mostly pale-yellow freckled; eye spots black; vertex black; frons and labrum pale brown, the former spined medianly as well as marginally. Thorax, dorsum darkened from A mesothorax to and including C metathorax (D metathorax ?) and sometimes the entire dorsum from A mesothorax to and including C (D?) of urite 9 darkened (fig. 73). Annulet A smaller than annulet B and C and spined, annulet B and C large and thickly spined, and annulet D bare, narrow, indistinct, and unspined (fig. 61). Uropods normally developed on urites 2–7; urite 8 with pair of small but distinct adventral protuberances; urite 9 with similar but smaller, less distinct protuberances. (These structures on urites 8 and 9, as those on urite 9 of *Cladius*, are doubtless uropods which, since the larvae are surface feeders and do not grip the leaf by curling the apex of the abdomen, are retained, though not developed by much use.)

Distribution.—The species of this genus are distributed throughout the Palaearctic Region; one is known from the northern Oriental Region; and several occur in Nearctic Region, where they are confined almost entirely to the eastern part of the Transition and Canadian Zones.

Specific Characters.—In the adults the shape of the sheath, the exact dentation of the lancet plates, the character of the frontal crest, and the presence or absence of foveae in the postocellar area offer the best structural characters for separating the species. The color of the legs, even to the number of tarsal joints which are black or infuscated, is very useful in separating the species, and for all of the species here treated it is found to be surprisingly constant.

KEY TO THE ADULTS.

The species petrinus (Cockerell) and infuscatus (MacGillivray) are omitted from the following key (see also footnote 1):

1. Females ---------- 2
   Males ---------- 11
2. Lower walls of ocellar basin strong, keel-like, sharply broken by the middle fovea, the lateral walls sharply defined, linelike; postocellar area separated by a median furrow; wings with a dusky band below the stigma; antennae long, sharply tapering; trochanters white ---------- crataegi Rohwer.
   Lower walls of occellar basin not especially strong, rounded, not or only feebly broken by the middle fovea; the lateral walls obsolete or poorly defined; postocellar area convex, with, at most, a fovea anteriorly ---------- 3
3. Postocellar area without a fovea near the middle of the anterior margin ---------- 4
   Postocellar area with a fovea near the middle of the anterior margin ---------- 8
4. Distinct large, somewhat triangular-shaped depression in front of the anterior ocellus; hind tarsi and all of the trochanters black ---------- betulae Rohwer.
   No large or triangular-shaped depression in front of the anterior ocellus ---------- 5
5. Recurrentella distinctly postfurcal ---------- rubivorus Rohwer.
   Recurrentella antefurcal ---------- 6
6. Wings before of the anterior margin of the stigma, brownish; trochanters and hind tarsi brownish black ---------- salicivorus Rohwer.
   Wings uniformly hyaline; trochanters and hind tarsi white ---------- 7
7. Middle fovea deep, large ---------- solitaris (Dyar).
   Middle fovea practically obsolete ---------- montanus Rohwer.
8. Trochanters black; ocellar basin entirely obsolete; frontal crest unbroken; sheath oblique above, obtusely rounded apically, tapering to a broad base; antennae long, slender, sharply tapering apically ---------- rubi Rohwer.
   Trochanters white; at least the lower wall of the ocellar basin distinctly present ---------- 9
9. Frontal crest not broken medianly; antennae slightly shorter and not strongly tapering; wings brownish basally ---------- pruni Rohwer.
   Frontal crest broken medianly; antennae slightly longer and sharply tapering apically ---------- 10
10. Wings strongly brownish basally ---------- virginianus Rohwer.
    Wings uniformly hyaline ---------- plesius Rohwer.
11. Postocellar area with a small distinct fovea at the anterior middle; trochanters white; hind tarsi mostly white ---------- 12
    Postocellar area without a fovea at the anterior middle; trochanters and hind tarsi brownish ---------- 13

12. Frontal crest not broken by median fovea------------------pruni Rohwer.
Frontal crest distinctly broken by the deep middle fovea--aequalis (Norton).
13. A distinct depression in front of the anterior ocellus--------betulae Rohwer.
No depression in front of the anterior ocellus----------salicivorus Rohwer.

KEY TO THE LARVAE.

A. Larvae feeding on *Salix*----------------------------------salicivorus Rohwer.
B. Larvae feeding on *Crataegus*----------------------------crataegi Rohwer.
Larvae feeding on *Prunus serotina*-------------------------pruni Rohwer.
plesius Rohwer.
virginianus Rohwer.
Larvae feeding on *Betula populifolia*--------------------betulae Rohwer.
Larvae feeding on *Rubus*--rubi Rohwer.
Larvae feeding on *Alnus*--------------------------------solitaris (Dyar).

On characteristics other than host plant these larvae can not be separated specifically, however, differences in the extent of coloration of the head divides those larvae available for study into the following two species groups:

A. Head with a small (not reaching more than half way to edge of cranium) black spot surrounding eye; figure 56----------------salicivorus Rohwer.
B. Head with a large (reaching almost to edge of cranium) black spot surrounding eye; figure 55--crataegi Rohwer.
pruni Rohwer.
betulae Rohwer.
virginianus Rohwer.
solitaris (Dyar.)

PRIOPHORUS CRATAEGI Rohwer, new species.

Female.—Length, 5 mm.; length of the antenna, 4.5 mm. Clypeus shining with sparse, setigerous punctures, basal middle strongly convex, the anterior margin broadly, shallowly, arcuately emarginate, lobes sharply pointed; supraclypeal fovea deep, punctiform; middle fovea large nearly circular in outline with sharply sloping walls; ocellar basin completely defined, lower walls sharp, keel-like and broken by the middle fovea; the lateral walls linelike; antennal furrows poorly defined; postocellar area sharply defined laterally, convex, parted by a furrow medianly; postocellar furrow obsolete; postocellar line subequal with the ocellocular line; antenna sharply tapering, the third joint distinctly shorter than the fourth, the apical joint slightly longer than the preceding; stigma broadly rounded below, obliquely truncate apically; first intercubitus obsolescent; third cubital slightly longer than the second on the radius; the radiellan cell without an appendage; sheath broad, straight above, obliquely truncate apically, then sharply tapering to the base. Black; trochanters, four anterior tibiae and tarsi (the apical joints of the tarsi are infuscated), the basal two-thirds of the posterior tibiae and the three basal joints of the hind tarsi white; wings subhyaline, with a dusky band below the stigma; venation dark brown.

Type locality.—East River, Connecticut.

Described from one female reared from a larva collected on *Crataegus* by Chas. R. Ely, and recorded under Bureau of Entomology Number, Hopk. U. S. 13649[k].

Type.—Cat. No. 21587, U.S.N.M.

Larva.—Length 10 mm. similar to and with apparently no characters distingushing it from that of *P. pruni* Rohwer. All the larvae examined were quite dark, blackish along the dorsum.

Host.—*Crataegus*, species.

Seasonal History.—Larvae, collected in early July, became prepupae and spun cocoons by the twenty-seventh, from which adults had emerged August third.

PRIOPHORUS BETULAE Rohwer, new species.

Figure 51.

Female.—Length 3.5 mm.; length of the antenna about 3 mm. Clypeus shining, almost without punctures, not strongly convex basally, the anterior margin rather deeply, arculately emarginate, the lobes nearly triangular in outline; supraclypeal foveae deep, punctiform; middle fovea shallow, wedge-shaped in outline; antennal furrows poorly defined along the ocelli; ocellar basin obsolete laterally, the lower wall rounded, broken; a distinct triangular depression in front of the anterior ocellus; postocellar area sharply defined laterally, convex, without foveae; postocellar furrow wanting; postocellar line subequal with the ocellocular line; antenna rather short, not sharply tapering, the third joint distinctly shorter than the fourth, the apical joint slightly shorter than the preceding; stigma rounded below, obliquely truncate apically; first intercubitus obsolescent; the third cubital on the radius distinctly shorter than the second; radiellan cell with a very short appendage; sheath obtusely pointed apically, straight above, tapering to a broad base. Black; the four anterior tibiae and tarsi (the apical joints of the intermediate tarsi are infuscated), and the basal two-thirds of the posterior tibiae white; wings strongly brownish, subhyaline beyond the apex of the stigma.

Male.—Length 4.5 mm.; length of the antenna 3.5 mm. In structure and color the above description of the female applies well to the male, except the middle fovea is smaller with more sharply sloping walls and the radiellan cell is entirely without an apendage; hypopygidium broadly rounded apically; antenna very hairy, the third joint considerably shorter than the fourth, concave below and very faintly produced basally so it is fully as broad at the base as the pedicel, the entire joint one-fifth broader than the fourth; the apical joint distinctly shorter than the preceding.

Type locality.—East River, Connecticut.

Described from two females (one type) and two males (one allotype) reared from larvae collected on *Betula populifolia* by Chas. R. Ely, and recorded under Bureau of Entomology Number Hopk. U. S. 10754^{c2} (type and allotype) and 10757^{f} (paratypes).

Type.—Cat. No. 21588, U.S.N.M.

Larvae.—Similar to *P. pruni* Rohwer but in the few specimens available for study, entirely pale excepting a faint grayness laterally on the mesothorax and metathorax and ninth abdominal segment. These larvae, however, were young, the largest being only 6.5 mm. in length.

Host.—*Betula populifolia.*

Seasonal History.—Solitary feeders from the underside of the leaf similar to *P. pruni* Rohwer. Larvae collected about one-half or two-thirds grown on August 25 spun coccoons August 30 and transformed to pupae September 4. The adults emerged September 16.

PRIOPHORUS RUBIVORUS Rohwer, new species.

A small species readily distinguished by the postfurcal recurrentella. The eastern *rubi* is much larger and is very easily separated by the presence of a median fovea in the postocellar area.

Female.—Length, 4.5 mm.; length of antenna about 3 mm. Clypeus gently convex, the anterior margin not depressed, broadly and very shallowly emarginate, lateral angles (no distinct lobes) obtusely rounded; supraclypeal foveae deep but not distinctly separated from the antennal foveae; middle fovea very shallow, elongate, not sharply defined or breaking through the crest; ocellar basin very poorly defined, the walls obsolete above and broadly rounded below; antennal furrows obsolete opposite the ocellar basin; a rather distinct, small depression both immediately before and behind the anterior ocellus; postocellar line subequal with the ocellocular line; postocellar furrow wanting; postocellar area without a median fovea on anterior margin, sharply defined laterally by the slightly diverging vertical furrows; antenna rather short, tapering, the third and fourth joints subequal stigma short, broad, but little more than twice as long as greatest width, rounded below; first intercubitus obsolescent; three abscissae of radius subequal in length; second cubital cell on radius about two and one-third times as long as third intercubitus; radiellan cell closed and with a short appendage; recurrentella postfurcal by about half the length of intercubitella; sheath broad, pointed apicaly. Black; palpi dark brown, tegulae almost entirely black; hind trochanters, tibiae and tarsi, except the infuscate apices of hind tibiae and apical joints of all tarsi, yellowish-ferruginous; wings hyaline; venation brown.

Type locality.—Portland, Oregon.

Described from a single female recorded under Bureau of Entomology number Quaintance 14055 collected by E. J. Newcomer, August 10, 1917 and labeled "On raspberry."

Type.—Cat. No. 23557, U.S.N.M.

PRIOPHORUS SALICIVORUS Rohwer, new species.

Figures 20, 21, 34, 35, 41, 47, 56.

Female.—Length 4.5 mm.; length of antenna 3.5 mm. Clypeus shining, strongly convex medianly, the apical margin broadly, shallowly, arcuately emarginate; supraclypeal foveae punctiform, small, not much deeper than the antennal foveae; middle fovea oval in outline; ocellar basin with the lateral walls obsolete, the lower wall poorly defined, rounded and unbroken; antennal furrows obsolete below the ocelli; postocellar area gently convex (incompletely defined laterally by a foveaeform depression); postocellar furrow obsolete; a faint depression behind the anterior ocellus; antennae as in figures 20 and 34, short, not tapering, the third joint distinctly shorter than the fourth, the apical joint subequal with the preceding; first intercubitus obsolescent; third cubital cell on the radius, slightly longer than the second; stigma short, broad at base, gradually tapering to the apex; radiellan cell with a short distinct appendage; sheath straight above, sharp apically tapering from the broad base, as seen from below the sheath is narrow, ovipositor as in figures 41 and 47. Black; four anterior tibiae and tarsi (the apical joints and all of the intermediate tarsi are brownish) and the basal two-thirds of the posterior tibiae, extreme base of the posterior basitarsus, whitish; wings strongly brownish basally, subhyaline beyond the apex of the stigma.

Male.—Length, 4 mm. The male differs from the above description of the female in having the middle fovea more elongate and deeper, breaking completely through the lower wall of the ocellar basin; hypopygidium narrowly rounded; posterior tibiae entirely brownish; antennae (see figs. 21 and 35) pale beneath, the third joint broader than the fourth but simple; radiellan cell with a very short appendage.

Type locality.—East River, Connecticut.

Described from three females (one type) and two males (one allotype) reared from larva collected on *Salix* by Chas. R. Ely, and recorded under Bureau of Entomology number Hopk. U. S. 13656[a].

Type.—Cat. No. 21589, U.S.N.M.

Larva.—Length, 11 mm. Black spot at vertex small; black spot about each eye also small and not extending more than half way to edge of cranium (fig. 56). Otherwise the larvae are similar to those previously described, with dorsum pale between the grayish thorax and the markings on eighth and ninth urites.

Host.—*Salix*, species.

Seasonal History.—Larvae collected July 27, cocooned August 5, transformed to pupae August 21, emerging as adults August 24.

PRIOPHORUS SOLITARIS (Dyar).

Cladius solitaris DYAR, Can. Ent., vol. 27, 1895, p. 192 and p. 340.

Priophorus solitaris Dyar, DYAR, Journ. N. Y. Ent. Soc., vol 8, 1900, p. 28.—MACGILLIVRAY, Bull. 22, Conn. Geol. Nat. Hist. Survey, 1916 (1917), p. 110.

Type.—Cat. No. 4129, U.S.N.M.

Female.—Length, 5 mm. Clypeus flat, anterior margin subsquarely emarginate, the lobes triangular, obtusely rounded; supraclypeal foveae deep, punctiform; middle fovea broad, shallow; ocellar basin obsolete laterally, the lower wall rounded, faintly broken; antennal furrows obsolete below the ocelli; postocellar area flat, sharply defined laterally with a faint longitudinal line medianly; postocellar furrow feebly defined; antennae broken but apparently long, slender; first intercubitus obsolete; second and third cubital cells subequal on the radius; stigma long, narrow, broader at base, gradually tapering to the apex; radiellan cell with a very short appendage; sheath straight above, gradually rounded to the broad base. Black; trochanters, four anterior tibiae and tarsi, the posterior tibiae except apices and the posterior tarsi except the apices of the joints, white; wings uniformly subhyaline, venation pale brown.

Redescribed from the unique type.

The following description is arranged from Dyar:

Larva.—Solitary feeder, eating the parenchyma of the leaf from the underside.

STAGE III.—Head round; shining black pilose, width, 0.5 mm.; thorax a little enlarged, thoracic feet faintly yellowish tinged; abdominal feet slightly spreading, segments distinct, rather faintly three annulate;[13] annulet first small, second and third with many pale setae, so that the larva is pilose or hairy; color, translucent whitish, with no yellow tint; the food gives a dark green broad line by transparency, as far as joint twelve, in join thirteen the fasces show black.

STAGE IV.—Head pale whitish, with a black shade at side and vertex; width .8 mm.; body whitish, with a faint greenish tinge, densely hairy; the tubercles slight; alimentary canal gives a dark shade.

STAGE V.—Head greenish, thickly dotted with brown; a confluent black patch on clypeus, over eye and above and behind it; or a patch

[13] Doubtless 4 annulate with A, B, and C visible and haired while D is hidden—annulet first probably A, second and third probably B and C.

at vertex and another on side covering the eye and reaching to the back of head; head shining, pilose; mouth brown, width 1 mm.; dorsal region of body olivaceous blackish; joint second anteriorly[14] subventral region,[15] venter, feet, and joint thirteen[16] posteriorly translucent whitish, not shiny; body pilose, the hairs arising from thickly placed pale tubercles on each of the three annulets; hairs rather short and pale.

Cocoon.—Double, made of white or brownish silk, large and resembling thin paper.

Host.—*Alnus*, species.

PRIOPHORUS MONTANUS Rohwer, new species.

Closely allied to *solitaris* (Dyar), but is somewhat larger and more robust and the middle fovea is practically obsolete.

Female.—Length, 5.5 mm.; length of antenna about 3.75 mm. Clypeus rather distinctly convex medianly, the apical margin broadly acruately emarginate, not depressed; suprarcylpeal foveae large, deep; middle fovea very shallow and indistinctly defined, practically obsolete, not breaking through the crest; ocellar basin obsolete dorsally, the lower wall very poorly defined, rounded; a very small U-shaped depression in front of the anterior ocellus; antennal furrows obsolete; postocellar area without a pit in the anterior middle, distinctly limited laterally by the nearly complete vertical furrows; postocellar furrow wanting; postocellar line distinctly longer than the ocellocular line, but not quite twice as long as the ocelloccipital line; antenna rather long, slender, distinctly tapering apically, the third and fourth joints subequal in length; stigma rather large, angled near base then rapidly tapering to apex, about two and one-third times as long as greatest width; first intercubitus obsolescent; first abscissa of radius longer than the second and subequal in length with the third; second abscissa of radius not quite twice as long as the third intercubitus; radiellan cell closed and with a short appendage; recurrentella distinctly antefurcal; sheath broad, rounded apically. Black; tegulae brownish; apical joints of palpi, tibiae and tarsi except the infuscate apical joints (posterior ones more broadly) and hind trochanters, yellowish; wings uniformly dusky hyaline; venation brown, except the costa and base of cubitus which are pale brown.

Type locality.—Belgrade, Montana.

Described from three females (one type) collected July 14, 1909, and sent in under number 228 by an unknown collector.

Type.—Cat. No. 23558, U.S.N.M.

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[14] Mesothorax.
[15] Epipleural, pleural, and hypopleural regions.
[16] Urite nine.

PRIOPHORUS RUBI Rohwer, new species.

Female.—Length 6 mm.; length of the antenna 4 mm. Clypeus flat, shining, slightly convex in the basal middle, anterior margin rather deeply arcuately emarginate; lobes triangular in outline, rather sharply pointed; supraclypeal foveae deep, punctiform; middle fovea shallow, circular in outline; ocellar basin entirely wanting; antennal furrows nearly complete; a small wedge-shaped depression in front of the anterior ocellus; postocellar line subequal with the ocellocular line, and but little shorter than the ocelloccipital line: postocellar area convex, sharply defined laterally, with a small fovea in the anterior middle; postocellar furrow wanting; antenna rather short, sharply tapering; the third joint distinctly longer than the fourth; the apical joint somewhat longer than the preceding; stigma short, rounded below, its greatest width at about the middle; first intercubitus obsolescent; second cubital cell on the radius subequal with the third; radiellan cell with distinct appendage; sheath straight above, obtuse at apex, tapering from the broad base. Black; anterior tibiae and tarsi, the posterior tibiae and most of the posterior tarsi white; posterior margin of the tegulae whitish; wings hyaline, iridescent, venation dark brown.

Type locality.—Northeast, Pennsylvania.

Described from one adult which was reared from a larva collected on Blackberry. This larva formed a cocoon on June 11, was a pupa on June 16 and an adult on the 23 and emerged on the 24. Material collected and reared by R. A. Cushman.

Type.—Cat. No. 21594, U.S.N.M.

Another female of this species was collected at Hamburg, New York, June 14, 1911, by M. C. Van Duzee.

PRIOPHORUS PRUNI Rohwer, new species.

Figures 15, 22, 32, 33, 48, 55, 61, 73.

Female.—Length 5 mm.; length of the antenna 4 mm. Clypeus gently convex, shining, not prominent in the basal middle; the anterior margin broadly, shallowly, arcuately emarginate; the lobes short and obtuse, apically; supraclypeal foveae punctiform, middle fovea elongate, deep, with sloping walls, not breaking through the frontal crest; lower wall of ocellar basin defined, the lateral walls are obsolete; antennal furrows wanting below the ocelli; postocellar area flat, sharply defined laterally, with an elongate fovea in the anterior middle; postocellar furrow wanting; postocellar line slightly shorter than the ocellocular line; antenna short, the third and fourth joints subequal, the apical joint subequal with the preceding (see figs. 15 and 33); stigma short, broadest at base, gradually tapering to the apex; first intercubitus obsolescent; second cubital on

the radius distinctly shorter than the third; radiellan cell without an appendage; sheath oblique above, sharply pointed apically and tapering to a broad base; lancet as in figure 48. Black; trochanters, the four anterior tibiae and tarsi, the posterior tibiae except apices, and the first four joints of the posterior tarsi, white; wings fuliginous, subhyaline beyond the apex of the stigma.

Male.—Length 4.5 mm.; length of the antenna 3 mm. Hypopygidium broadly rounded. The above description of the female applies well to the male. The antenna (see figs. 22 and 32) are slightly brownish beneath.

Type locality.—East River, Connecticut.

Described from two females (one type) and two males (one allotype), reared from larvae collected on *Prunus serotina* by Chas. R. Ely, and recorded under Bureau of Entomology number Hopk. U. S. 13660 *i*.

Type.—Cat. No. 21595, U.S.N.M.

Oviposition.—The eggs are placed in punctures in the midrib of the leaf.

Larva.—(Fig. 73.) Length of full fed larva, 11 mm. Head pale, tan freckeled; frons and labrum tan; clypeus, ventral mouthparts, mandibles and cranium about antennae pale; black spot about eye large, extending posteriorly almost to cranium; black spot at vertex large (fig. 55). Thorax with mesothorax and metathorax darkened dorsally from above epipleurite gray to almost black, age and size of the larva increasing the extent and depth of the color. Abdomen of young larvae almost entirely pale excepting grayish dorsum of eighth and ninth urites. In larger larvae the dorsum of the eighth and ninth urites is gray or blackish, where gray, the dorsum of the abdomen is pale, where blackish, the dorsum of the abdomen is gray. Annulet A with from 4 to 6 pairs of small spines, annulets B and C with numerous spines arranged in clusters forming transverse rows across the dorsum, and annulet D narrow, indistinct, and without spines (fig. 61).

Cocoon.—Length 8 mm.; width 3 mm. Transparent, pale brown, thin walled, irregularly oval, attached to leaves, dirt, or side of rearing cage.

Host.—Prunus serotina.

Parasites.—Mesoleptine pupae found in cocoons (determined by S. A. Rohwer).

Seasonal history.—Solitary feeders, the young larvae skeletonizing the leaf from the under surface while the older larvae eat holes through from the under side. Larvae collected August 16th, spun cocoons August 21, and transformed to pupae August 25th, emerging as adults August 30th. September 2d of the same year more larvae

were collected. These spun by September 12th, but did not emerge as adults until April 13th of the following year.

PRIOPHORUS AEQUALIS (Norton).

Cladius aequalis NORTON, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 78.
Priophorus aequalis (Norton), KIRBY, List Hym. Brit. Mus., vol. 1, 1882, p. 101.—MACGALLIVRAY, Bull. 22, Conn. Nat. Hist. Geol, Survey, 1916 (1917), p. 109.

A single male, with apices of antennae wanting and right fore wing on pin, without locality label but a name label in Norton's handwriting, is in the collection of the Academy of Natural Sciences of Philadelphia. This specimen agrees perfectly with the original description and is with but little doubt from the type series. It may be designated as electotype.

The species is closely allied to *pruni* but may be easily separated by the middle fovea breaking through the crest. It agrees well with the species here described as *virginianus*, and it is not unlikely that it will prove to be the male of that species.

Male.—Length, 5.5 mm. Anterior margin of the clypeus broadly, shallowly, arcuately emarginate; lobes small and obtuse; median fovea deep, well defined, elongate, breaking through the frontal crest; ocellar basin obsolete dorsally; a faint impression in front of anterior ocellus; antennal furrows present but not strong; postocellar area very narrow, distinctly limited laterally, and with a distinct median fovea anteriorly; postocellar furrow wanting; third antennal joint distinctly shorter and slightly broader than the fourth, with a faint swelling at base beneath; stigma rather broad, about three times as long as greatest width which is at base and from which it tapers to apex; first intercubitus obsolescent; first abscissa of radius shorter than the second, which is subequal with the third; second cubital on the radius about two and one half times as long as third intercubitus; second recurrent distinctly before the middle; radiellen cell closed and with a short appendage; hypopygidium broadly rounded apically. Black; palpi, four posterior trochanters, four anterior tibiae and tarsi, posterior tibiae and tarsi, except apical tarsi and apices of tibiae which are brownish, whitish; anterior femora reddish beneath; wings brownish to apex of stigma, then hyaline; venation dark brown.

Description of above-mentioned specimen.

Distribution.—Farmington, Connecticut.

PRIOPHORUS VIRGINIANUS Rohwer, new species.

It is not unlikely that more material will prove that this is the undescribed female of *aequalis* (Norton).

Female.—Length 5 mm.; length of the antenna 4.25 mm. Clypeus strongly convex medianly; anterior margin broadly, arcuately emar-

ginate; the lobes very obtuse; supraclypeal foveae deep, nearly circular in outline; middle fovea elongate, oval in outline, with sloping walls, breaking through the frontal crest; lower walls of the ocellar basin rounded; lateral walls nearly obsolete; a shallow, poorly defined depression in front of the anterior ocellus; antennal furrows poorly defined below the ocelli; postocellar area gently convex, sharply defined laterally with an elongate fovea in the anterior middle; postocellar furrow wanting; antenna rather long and sharply tapering, the third joint slightly shorter than the fourth and with a projection at the base beneath apical joint distinctly longer than the preceding; stigma rather narrow, broader at base, gradually tapering to the apex; first intercubitus obsolescent; second and third cubital cells subequal on the radius; radiellan cell with a very short appendage; sheath straight above, obtuse apically, and tapering from the broad base. Black; trochanters, four anterior tibiae and tarsi, the posterior tibiae except apical third and the four basal joints of the posterior tarsi, white; wings fuliginous basally, subhyaline beyond the apex of the stigma.

Type locality.—Great Falls, Virginia.

Described from one female reared from a larva collected on *Prunus serotina* by S. A. Rohwer, and recorded under Bureau of Entomology number Hopk. U. S. 10718. This species was also collected and reared from the same host at Newington, Fairfax County, Virginia, by S. A. Rohwer.

Type.—Cat. No. 21596, U.S.N.M.

Larva.—Length, last stage, 11 mm. Black above with lower part of latus, legs, and beneath, white; head with usual black markings.

Pupa.—The antennae of the pupa, on reaching their full length, were composed of eighteen joints, the division between the regular nine joints more strongly marked.

Host.—*Prunus serotina.*

Seasonal History.—These larvae are solitary feeders from the under surface of the leaves, the younger larvae skeletonizing, the more mature larvae eating holes. A larva collected June 27, spun cocoons June 30, pupated July 2, and emerged as an adult July 16.

PRIOPHORUS PLESIUS Rohwer, new species.

Figure 4.

Female.—Length 5 mm.; length of the antenna 3.75 mm. Clypeus strongly convex; the apical margin rather deeply, subangulately emarginate; the lobes broad, triangular in outline; the apical margin acute; supraclypeal foveæ deep, circular in outline; middle fovea elongate, deep, with sloping walls, breaking through the frontal crest; lower walls of ocellar basin rounded; lateral walls

only faintly indicated; an elongate depression in front of the anterior ocellus; antennal furrows nearly obsolete below the ocelli; postocellar area strongly convex, sharply defined laterally, with a punctiform fovae in the anterior middle; postocellar furrow obsolete; antenna rather long, sharply tapering apically, the third joint distinctly shorter than the fourth; the apical joint slightly longer than the preceding; stigma narrow, broadest at base, sharply tapering to the apex; first intercubitus obsolescent; the second and third cubital cells subequal on the radius; radiellan cell with a short appendage; sheath straight above, obtuse apically tapering from the broad base. Black; trochanters, the four anterior tibiæ and tarsi, posterior tibiae except their apices, the four basal joints of the posterior tarsi, white; wings hyaline; venation dark brown, stigma pale brown.

Type locality.—Profile House, New Hampshire.

Described from three females (one type) reared from larvæ collected on cherry by Dr. H. G. Dyar, and recorded under his Number 6H.

Type.—Cat. No. 21597, U.S.N.M.

This species has also been collected at East River, Connecticut, in the larval stages on *Prunus serotina*, by Chas. R. Ely.

Larva.—"Spun within a day or two, before I had a chance to described it in detail. It was, however, strikingly colored, being reddish or brownish above and greenish below." (Ely.)

Host.—*Prunus serotina.*

Seasonal History.—A larva collected August 15, spun its cocoon August 17, emerging as an adult September 20.

PRIOPHORUS PETRINUS (Cockerell).

Cladius petrinus COCKERELL, Proc. Acad. Nat. Sci. Phila., (1914) 1915, p. 641.

A study of the original description and subsequent notes from the type kindly supplied by Professor Wickham, indicates that this species is more properly referred to the genus *Priophorus.*

This species was described from the shales of Florissant and the type is in the collection of Professor Wickham.

PRIOPHORUS INFUSCATUS (MacGillivray).

Craterocercus infuscatus MACGILLIVRAY, Bull. 22, Conn. Geol. Nat. Hist. Surv. 1916 (1917), p. 106.

Priophorus infuscatus (MacGillivray), ROHWER, Proc. Ent. Soc. Wash., vol. 20, 1918, p. 165.

Type.—Collection of A. D. MacGillivray.

Although the senior author examined the type of this species he is unable to definitely associate it with any of the species here de-

scribed. It is probably more closely allied to the species here described as *pruni.* The original description is as follows:

"Mesonotum and collar black; body black, with legs beyond femora white; third segment of antennae shorter than fourth; clypeus distinctly emarginate; median fovea large, shallow, circular; wings infuscated on basal half. Length 6 mm."

In a letter dated January 13, 1919, Doctor MacGillivray says: "The type of *Craterocercus infuscatus* was collected at Ithaca, New York, and is without date. The specimen is a female."

(PRIOPHORUS) CAULOCAMPUS ACERICAULIS (MacGillivray) Rohwer.

Figure 8.

Priophorus acericaulis MacGillivray, Can. Ent., vol. 38, 1906, p. 306.
Caulocampus acericaulis (MacGillivray) Rohwer, Proc. U. S. Nat. Mus., vol. 43, 1912, p. 240; Proc. Ent. Soc. Wash., vol. 20, no. 8, 1918, p. 165.

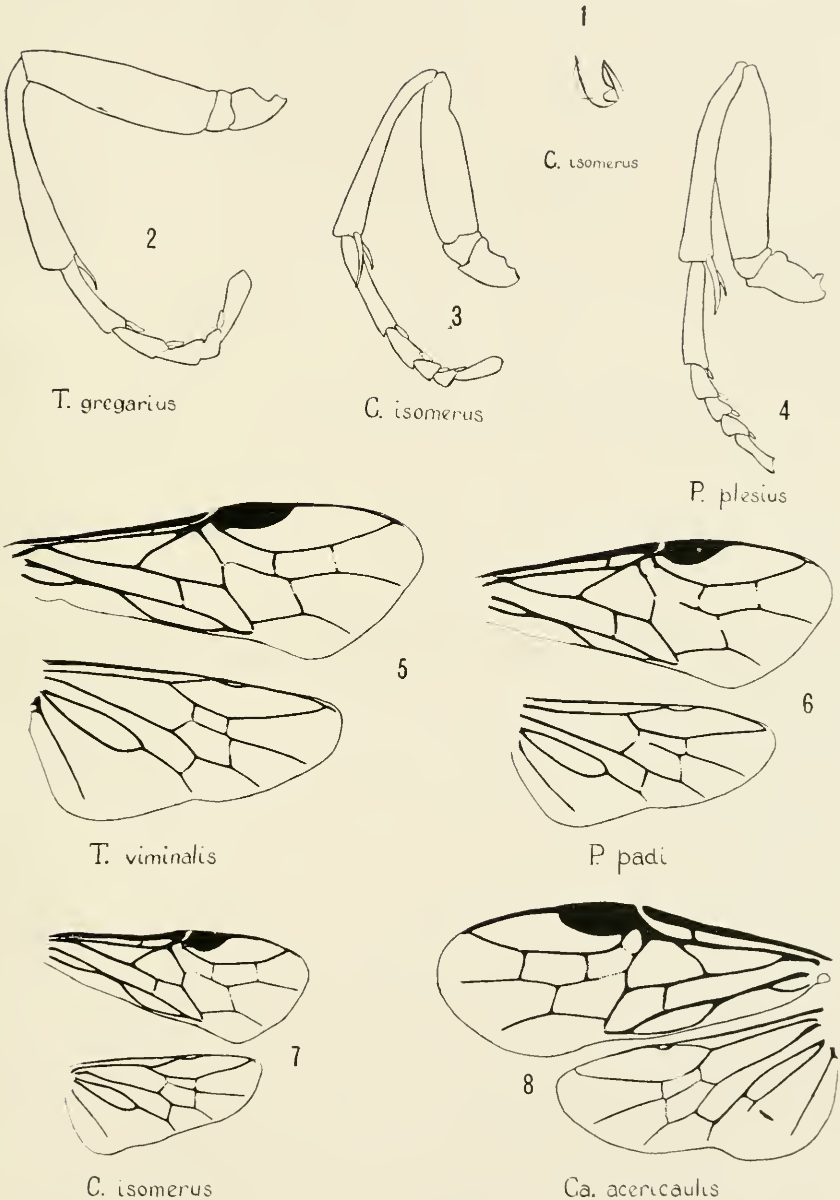
In his latest paper [17] MacGillivray leaves this species in the genus *Priophorus.* According to our opinion, it does not belong to this subfamily. The basal vein, which joins the subcosta remote from the origin of the cubitus (see fig. 8), the larvae and their habits are important characters which show that the species is Nematine. This species, according to our opinion, is generically different from *Priophorus*, and the genus *Caulocampus*, of which it is the genotype, should be placed in the Nematine, tribe Hemichorini.

[17] Bull. 22, Conn. Geol. and Nat. Hist. Survey, 1916 (1917), p. 109.

EXPLANATION OF PLATES.

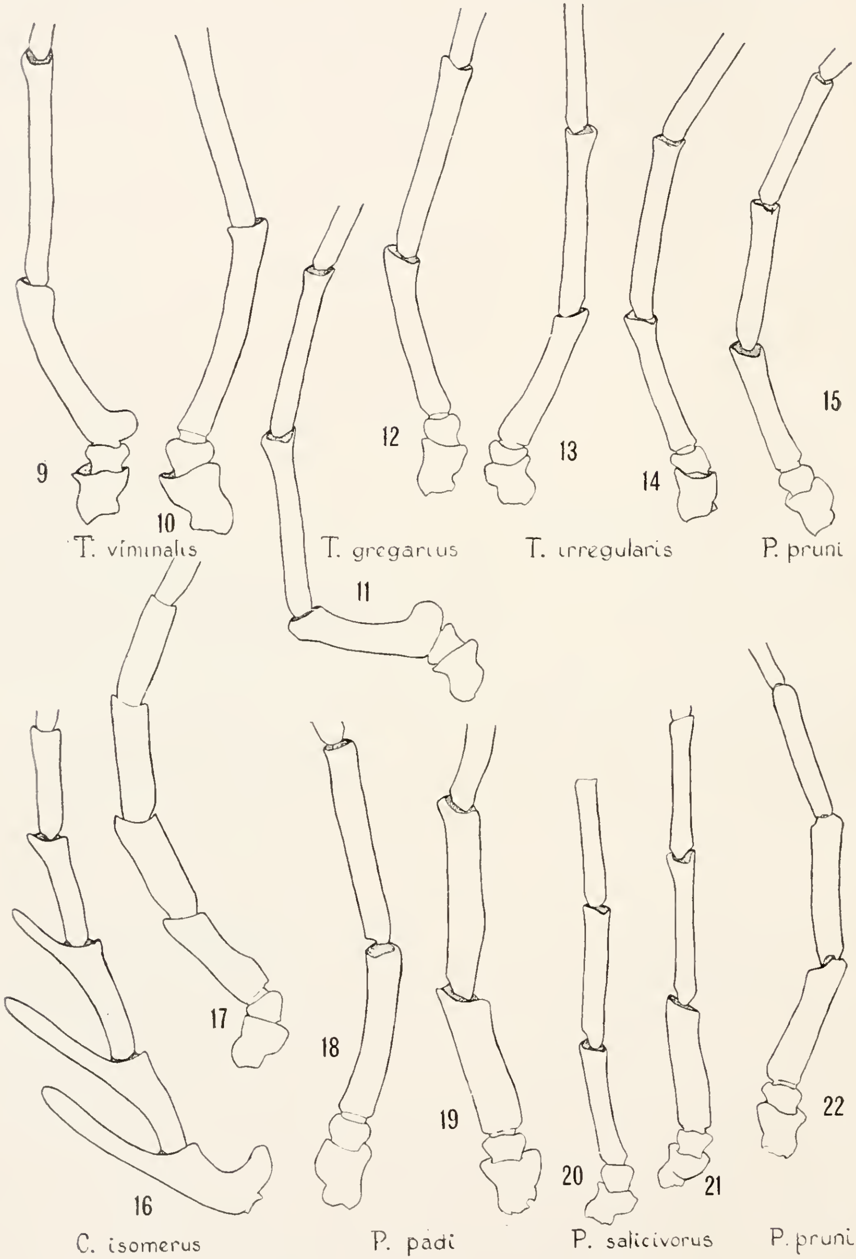
PLATE 1.—Legs and Wings of adult Cladiine sawflies.

FIG. 1. Claw of *Cladius isomerus.*
2. Leg of *Trichiocampus gregarius*, female.
3. Leg of *Cladius isomerus*, female.
4. Leg of *Priophorus plesius*, female.
5. Wings of *Trichiocampus viminalis*, female.
6. Wings of *Priophorus padi*, female.
7. Wings of *Cladius isomerus*, female.
8. Wings of *Caulocampus acericaulis.*



NORTH AMERICAN CLADIINE SAWFLIES.

FOR EXPLANATION OF PLATE SEE PAGE 38.



NORTH AMERICAN CLADIINE SAWFLIES.

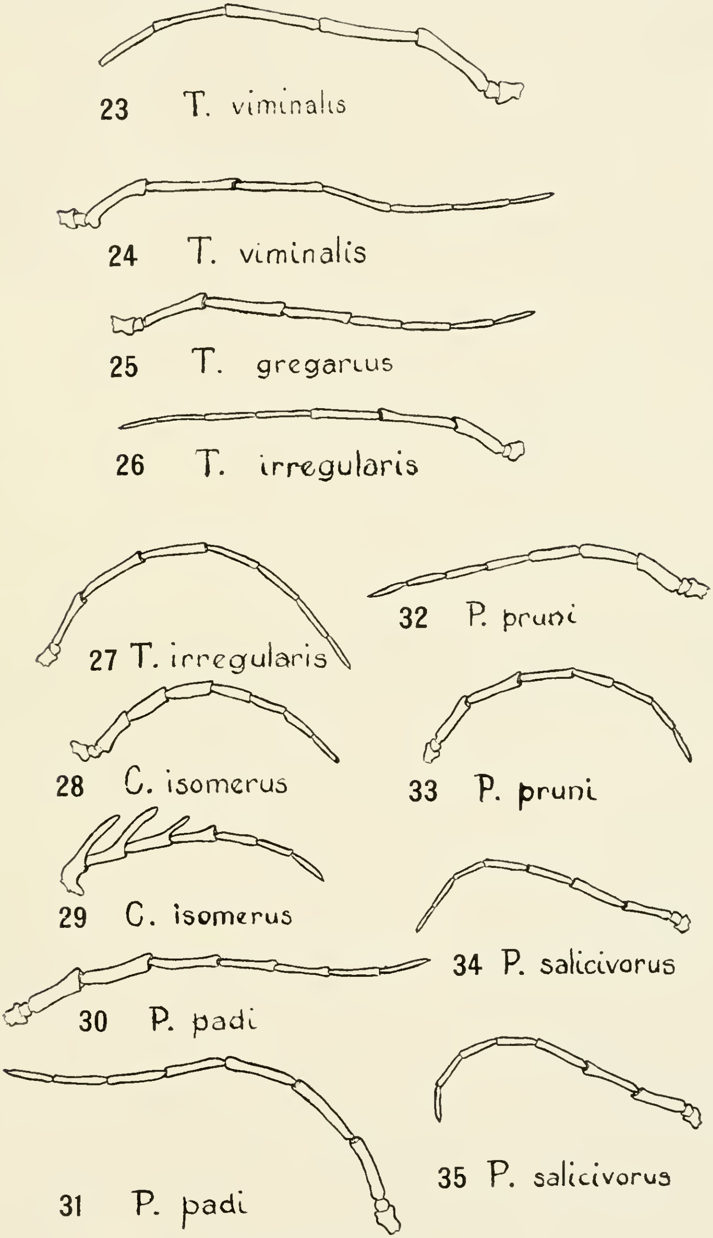
FOR EXPLANATION OF PLATE SEE PAGE 39

PLATE 2.—Antennae of adult Cladiine sawflies.

FIG. 9. Antenna of *Trichiocampus viminalis*, male.
10. Antenna of *Trichiocampus viminalis*, female.
11. Antenna of *Trichiocampus gregarius*, male.
12. Antenna of *Trichiocampus gregarius*, female.
13. Antenna of *Trichiocampus irregularis*, female.
14. Antenna of *Trichiocampus irregularis*, male.
15. Antenna of *Priophorus pruni*, female.
16. Antenna of *Cladius isomerus*, male.
17. Antenna of *Cladius isomerus*, female.
18. Antenna of *Priophorus padi*, female.
19. Antenna of *Priophorus padi*, male.
20. Antenna of *Priophorus salicivorus*, female.
21. Antenna of *Priophorus salicivorus*, male.
22. Antenna of *Priophorus pruni*, male.

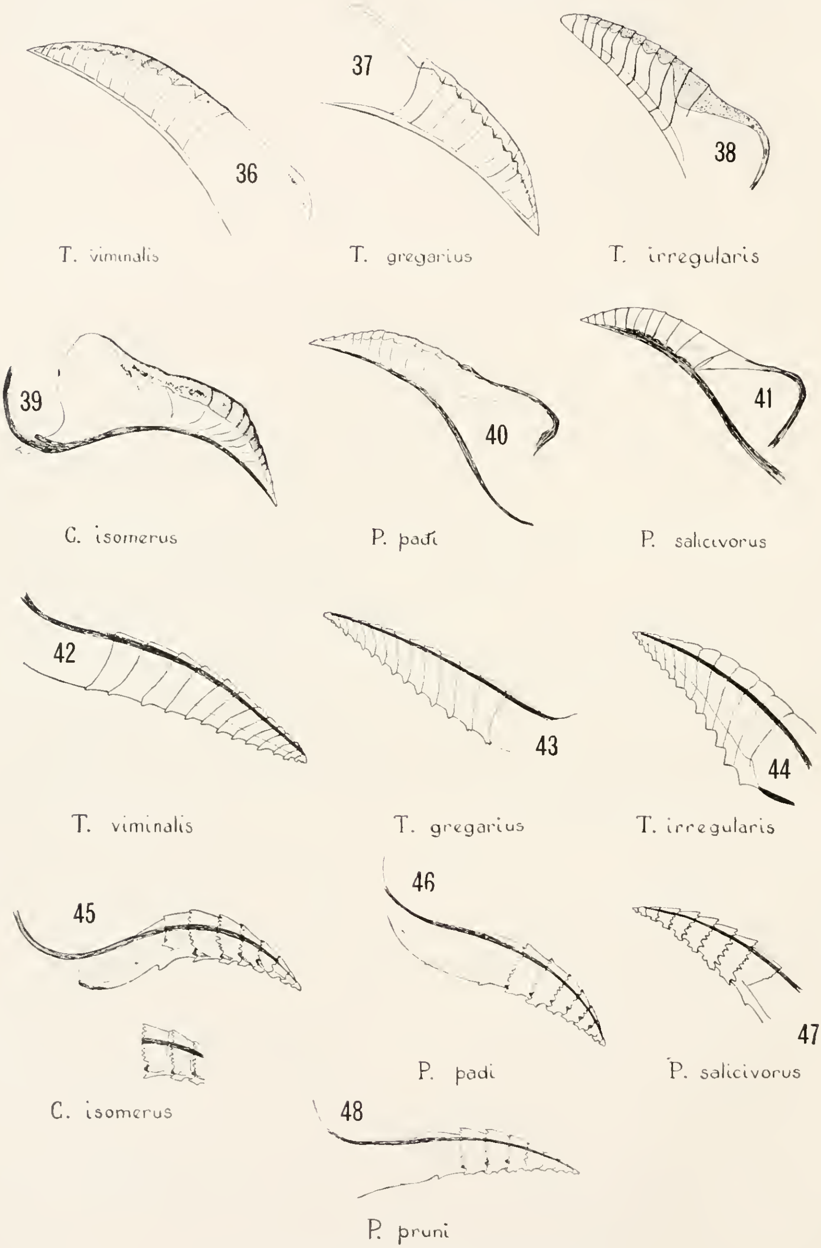
PLATE 3.—Antennae of adult Cladiine sawflies.

FIG. 23. Antenna of *Trichiocampus viminalis*, female.
24. Antenna of *Trichiocampus viminalis*, male.
25. Antenna of *Trichiocampus gregarius*, female.
26. Antenna of *Trichiocampus irregularis*, female.
27. Antenna of *Trichiocampus irregularis*, male.
28. Antenna of *Cladius isomerus*, female.
29. Antenna of *Cladius isomerus*, male.
30. Antenna of *Priophorus padi*, male.
31. Antenna of *Priophorus padi*, female.
32. Antenna of *Priophorus pruni*, male.
33. Antenna of *Priophorus pruni*, female.
34. Antenna of *Priophorus salicivorus*, female.
35. Antenna of *Priophorus salicivorus*, male



NORTH AMERICAN CLADIINE SAWFLIES.

FOR EXPLANATION OF PLATE SEE PAGE 40.



NORTH AMERICAN CLADIINE SAWFLIES.

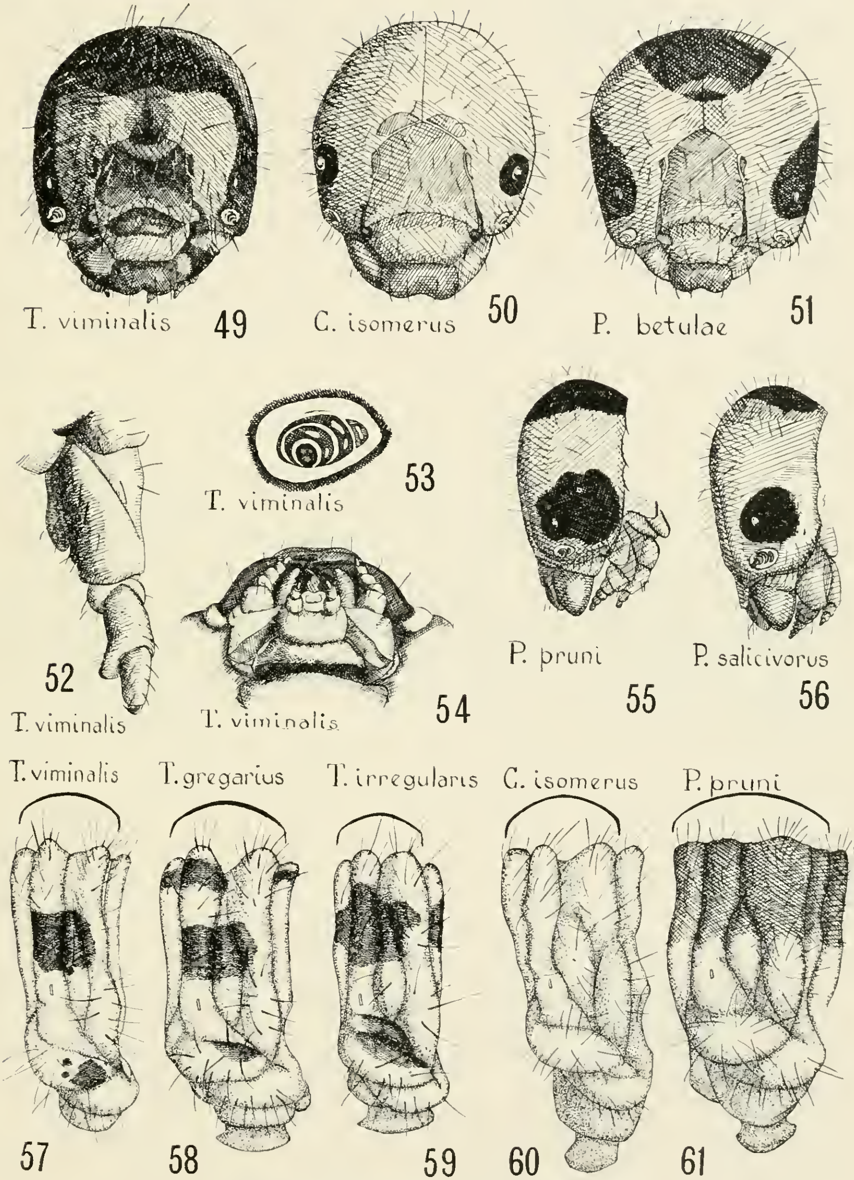
FOR EXPLANATION OF PLATE SEE PAGE 41.

PLATE 4.—Parts of the ovipositor of Cladiine sawflies.

FIG. 36. Lance of *Trichiocampus viminalis.*
37. Lance of *Trichiocampus gregarius.*
38. Lance of *Trichiocampus irregularis.*
39. Lance of *Cladius isomerus.*
40. Lance of *Priophorus padi.*
41. Lance of *Priophorus salicivorus.*
42. Lancet of *Trichiocampus viminalis.*
43. Lancet of *Trichiocampus gregarius.*
44. Lancet of *Trichiocampus irregularis.*
45. Lancet of *Cladius isomerus.*
46. Lancet of *Priophorus padi.*
47. Lancet of *Priophorus salicivorus.*
48. Lancet of *Priophorus pruni.*

PLATE. 5.—Larval characters of Cladiine sawflies.

FIG. 49. Front view of head, *Trichiocampus viminalis.*
50. Front view of head, *Cladius isomerus.*
51. Front view of head, *Priophorus betulae.*
52. Leg of larva, *Trichiocampus viminalis.*
53. Antenna of larva, *Trichiocampus viminalis.*
54. Mouth parts of larva, *Trichiocampus viminalis.*
55. Side view of head, *Priophorus pruni.*
56. Side view of head, *Priophorus salicivorus.*
57. Abdominal segment, plus annulet A of the following segment, *Trichiocampus viminalis.*
58. Abdominal segment, plus annulet A of the following segment, *Trichiocampus gregarius.*
59. Abdominal segment, plus annulet A of the following segment, *Trichiocampus irregularis.*
60. Abdominal segment, plus annulet A of the following segment, *Cladius isomerus.*
61. Abdominal segment, plus annulet A of the following segment, *Prio phorus pruni.*



NORTH AMERICAN CLADIINE SAWFLIES.

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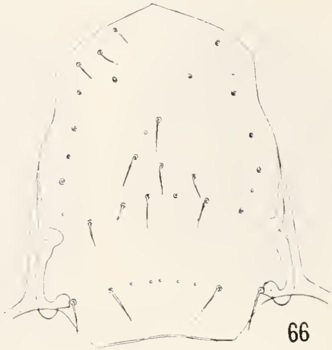

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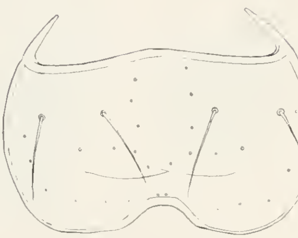

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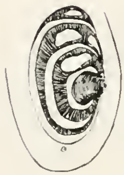

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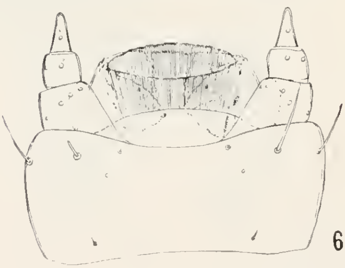

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NORTH AMERICAN CLADIINE SAWFLIES.

FOR EXPLANATION OF PLATE SEE PAGE 43

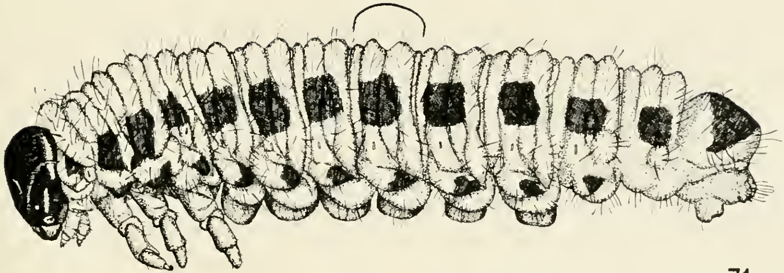
PLATE 6.—Larval details of *Cladius isomerus.*

FIG. 62. Maxilla of larva of *Cladius isomerus.*
63. Labrum of larva of *Cladius isomerus.*
64. Epipharynx of larva of *Cladius isomerus.*
65. Labium of larva of *Cladius isomerus.*
66. Frons of larva of *Cladius isomerus.*
67. Antenna of larva of *Cladius isomerus.*
68. Leg of larva of *Cladius isomerus.*
69. Ventral interior view—Right mandible of larva of *Cladius isomerus.*
70. Ventral interior view—Left mandible of larva of *Cladius isomerus.*

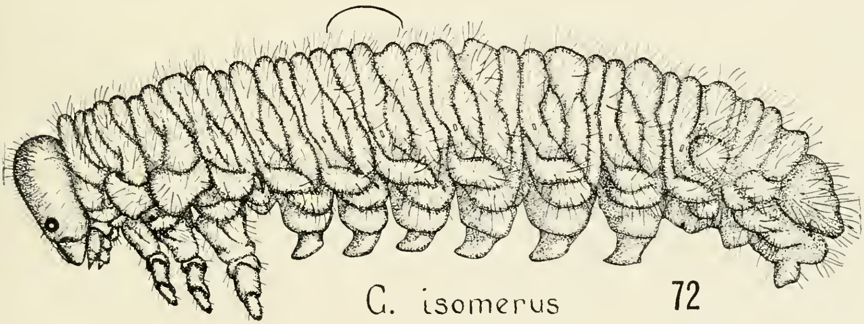
PLATE 7.—Larvae of Cladiine sawflies.

The bracket above a segment indicates the segment illustrated in detail on plate 5.

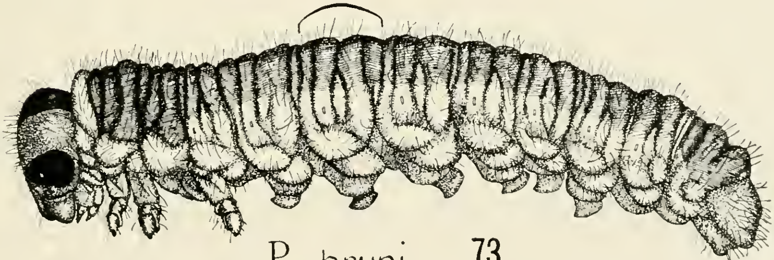
FIG. 71. Larva of *Trichiocampus viminalis.*
72. Larva of *Cladius isomerus.*
73. Larva of *Priophorus pruni.*



T. viminalis 71



C. isomerus 72



P. pruni 73

NORTH AMERICAN CLADIINE SAWFLIES.

FOR EXPLANATION OF PLATE SEE PAGE 43

INDEX.

This index contains the names of the species discussed in this paper. Valid generic names are in bold-face type, valid specific names in roman type, and synonyms in italics.

NEREIS (CERATONEREIS) ALASKENSIS, A NEW POLYCHAETOUS ANNELID FROM ALASKA.

By A. L. Treadwell,
Of the Department of Zoology, Vassar College, Poughkeepsie, New York.

Among the recent annelid accessions of the United States National Museum submitted to me for identification is an apparently undescribed polychaete. The single specimen was taken by Lieutenant Colonel C. A. Seoane, Signal Corps, United States Army, from the cable in Valdez Harbor, Alaska, which was brought aboard the United States Army Tender *Burnside* during repairs to the cable in December, 1920. The depth at this point was given as 200 fathoms.

NEREIS (CERATONEREIS) ALASKENSIS, new species.

Type specimen.—Cat. No. 19029, U. S. N. M.; Valdez Harbor, Alaska, in 200 fathoms.

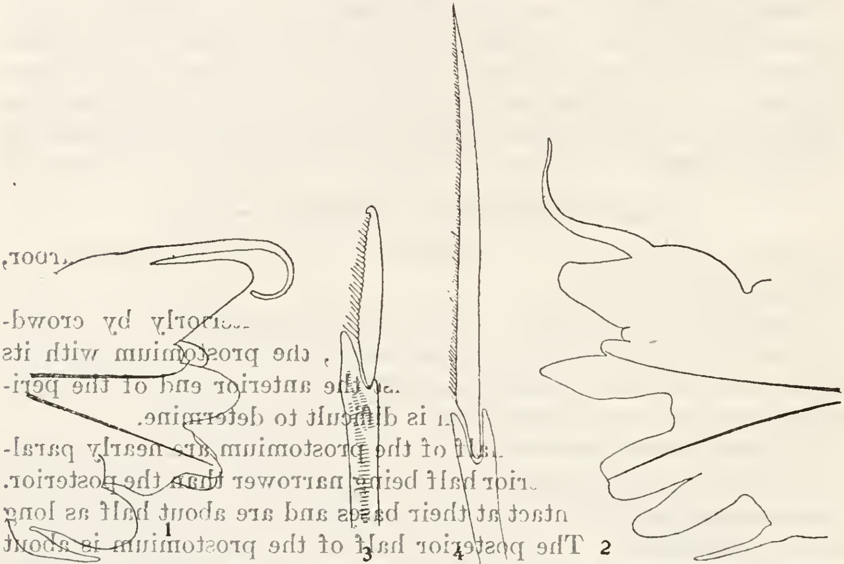
Description.—Apparently much distorted anteriorly by crowding into the bottle used for preservation, the prostomium with its appendages has been flattened against the anterior end of the peristomium so that its original form is difficult to determine.

The sides of the anterior half of the prostomium are nearly parallel to one another, the anterior half being narrower than the posterior. The tentacles are in contact at their bases and are about half as long as the prostomium. The posterior half of the prostomium is about twice as wide as the anterior, and has two pairs of very prominent dark eyes with large lenses. The palps are very prominent, attached to the prostomium for the greater part of its length. In the present condition of the specimen, the terminal joints of the palps are withdrawn into the basal portion, so that the latter has a truncated appearance.

On the right side the only tentacular cirri present are the two of the anterior pair and the ventral one of the posterior, while on the left only the two ventral ones remain. All are much shriveled, the longest, the dorsal one of the anterior pair on the right side, extending as far as somite 5. The anterior somites seem to be much contracted, so that it is probable that in the living individuals these cirri would not reach so far. Somite 2 is about one-third shorter than 1, which

is 1.5 mm. long and 5 mm. wide. The greatest body width is in the region of somite 6, where the diameter is 6 mm. The somites in general are about 0.75 mm. in length; the body is 95 mm. long, with approximately 120 somites. It tapers rapidly toward the posterior end, but no trace of anal cirri remain. Throughout the posterior half the dark dorsal blood vessel and anastomosing blood vessels on the dorsal surface of each somite give a dark color to the dorsal surface.

The jaws are long but not very stout, yellow at the base and chestnut colored at the apex. The teeth are not very distinct, but there seemed to be 7 on the left and 10 on the right. The proboscis was retracted, but dissection showed a total absence of paragnaths on



FIGS. 1–4.—NEREIS (CERATONEREIS) ALASKENSIS, NEW SPECIES. 1, 11TH PARAPODIUM × 18. 2, MIDDLE PARAPODIUM × 18. 3, VENTRAL SETA × 250. 4, DORSAL SETA × 250.

the basal portion. On the terminal portion I was absent, II not more than 3 very small scattered ones on either side, III and IV, 8 very small scattered ones, the distinction between III and IV not being very distinct.

The 11th parapodium (fig. 1) shows much less distinction between neuro and noto podium than occurs farther posteriorly. The dorsal notopodial lobe is large, thick, conical, with a very long and slender cirrus, extending to a considerable distance beyond its apex. The ventral lobe of the notopodium is also rounded, while the setal portion has a longer pre than post-setal lip. In the setal lobe of the neuropodium there is a conical post- and a rounded pre-setal portion, while the ventral neuropodial lobe is broadly rounded. The ventral

cirrus is clearly swollen at the base. A single acicula extends into each half of the parapodium.

A parapodium from the middle of the body (fig. 2) shows well separated notopodial and neuropodial portions, with aciculae which are very slender. The dorsal lobe of the notopodium is the larger, and carries the long slender cirrus at about midway of its length. The ventral lobe of the notopodium is asymmetrically lanceolate in outline, and a bilobed setal portion lies between it and the dorsal lobe. In the neuropodium the dorsal lobe is bluntly truncated at the apex, and the acicula reaches the surface at about its middle. The ventral lobe has a rounded apex, and the cirrus, with a swollen base, is attached to the body wall at a little distance from the neuropodium.

The setae are of two kinds. One (fig. 3) with a heavy basal portion, the apex asymmetrically bifid, the terminal portion rounded at the apex, with a row of fine hairlike processes along one edge. The other (fig. 4) has a more slender basal portion, symmetrically bifid at the apex, the terminal joint slender and flattened, much longer than in the first type, and with minute hairlike processes along one margin. There seemed to be variations in the size of the terminal joints, but, owing to the loss of many of them in the preservation, I could not get accurate information on this point. Those of the second group make up the notopodial tuft and the dorsalmost of the neuropodial one. Those of the first group occur in the ventral part of the neuropodial tuft.

MINERALOGY OF SOME BLACK SANDS FROM IDAHO, WITH A DESCRIPTION OF THE METHODS USED FOR THEIR STUDY.

By Earl V. Shannon,

Assistant Curator, Department of Geology, United States National Museum.

INTRODUCTION.

The term " black sand " is used commonly in gold placer mining districts to indicate the heavy concentrate from the placer gravels which accumulates with the gold in sluice boxes and on concentrating tables. The name, which is in very general use, comes from the fact that the predominant constituent is usually black in color. This black constituent, although commonly magnetite is sometimes largely ilmenite or in regions of serpentinous rocks it may consist in considerable part of chromite. Where the dominant constituent is not black in color local miners usually designate their heavy residues by some more appropriately descriptive name. Thus in southeastern Alaska much of the gold is recovered from " ruby sand " consisting predominantly of garnet; in the Florence and Warren districts in Idaho the heavy sand consisting very largely of colorless zircon is called " white sand " and sand rich in monazite in the placers of the Boise Basin is locally designated " yellow sand." In the present treatment these several varieties are referred to collectively as black or heavy sands.

These sands consist ordinarily of the heavier and rarer constituents concentrated from a great volume of disintegrated rock and may contain a great variety of unusual minerals. Many of these, in addition to being of high specific gravity, are quite hard, and as a consequence the heavy sands concentrated from stream gravels are in many places aggregates of glittering faceted crystals of minerals of various colors. Even relatively soft minerals occurring in the sands at times show few signs of abrasion, having escaped wear doubtless because of their small size and the rapidity of erosion.

The writer began an examination of the sands from Idaho preserved in the United States National Museum as part of the work of preparation of a lengthy manuscript on the minerals of that State. While of absorbing interest, the work proved to be tedious, and the limit to the amount of data obtainable from the study of the sands is prescribed by the amount of time available for their investigation. A single gram of the material may contain hundreds or even thousands of crystals which can not all be thoroughly examined in several days of steady work. The results obtained are not as complete or as conclusive as might be wished, but even thus they seem to indicate that some previous investigators have made errors in their identifications of some of the minerals. Under the circumstances this is far from surprising. Identifications must rest almost entirely upon the recognition of visible characters under the microscope and an ordinary monocular microscope is unsatisfactory for this purpose because of its limited field of vision and lack of focal depth. Chemical examinations of the aggregated minerals of a sand of mixed character are obviously little better than worthless and no single grain which may be selected has sufficient substance usually to yield distinctly visible qualitative or measurable quantitative chemical reactions. The modern methods of optical research by the use of immersion media of known refractive index, which are so indispensable in the study of fine-grained mineral aggregates are almost inapplicable in the study of these sands. This is due to the fact that nearly all of the minerals of interest are either opaque or have such exceedingly high indices of refraction as to fall well above the range of the series of stable immersion media available to any but a few specialists in optical mineralogy. In the present investigation the writer used a highly improved modern binocular microscope of the type recently manufactured by the Spencer Lens Company, of Buffalo, N. Y. This instrument presents a broad field with a splendid depth and sharpness of focus and it is possible to work in the field selecting individual grains and crystals with a wax tipped wire or a pair of forceps. Crystals were mounted in approximately vertical position on the wire and it was then the work of but a short time to orient them correctly for measurement on a Goldschmidt two-circle goniometer. The identity of some crystals was not even suspected until the angles measured had been carefully plotted and the symmetry thoroughly worked out.

The scheme of examination adopted, aside from the use of the goniometer, is relatively simple. The sands should be concentrated as far as possible by panning, or some other simple means of gravity concentration, thus eliminating the uninteresting lighter materials, as quartz, fragments of feldspar, micas, chlorite, etc. The remaining heavy concentrate should be carefully dried and then worked

over with a good magnet. The magnetic portion is usually largely magnetite, but some ilmenite is commonly magnetic. If platinum is sought the magnetic portion should be carefully examined, as a part or all of the platinum may be magnetic. The magnetite may also contain many grains of nonmagnetic materials, carried mechanically by the cohering particles of magnetite, but these are usually only accidental grains of the minerals most abundant in the nonmagnetic residue. Some minerals, not themselves magnetic, are very frequently rendered magnetic by the presence of small magnetite inclusions. The nonmagnetic residue may then be examined with a good lens or with a low to medium power microscope, using incident light from above the stage. A binocular microscope is best, if one is available. Many of the more common minerals may be readily identified by their form and color. Except in unusually coarse or water-worn sands, grains of the constituent minerals can be found which are bounded by bright crystal faces. By taking these up on a wire tipped with wax and tilting them backward and forward or rotating them, so as to observe the reflection of light from the faces, an idea can usually be gained relative to the symmetry of the crystal which may serve to identify the mineral when compared with the crystal figures in a textbook or with the drawings accompanying this paper. Gold and the platinum metals are easily recognizable, and their identifications can be confirmed by applying a drop of concentrated nitric acid and observing, through the microscope, whether it has any action.

Perhaps the greatest difficulty will be found in distinguishing between relatively opaque dark nonmagnetic grains, which may include chromite, ilmenite, limonite, and a number of rarer columbates, tantalates, titanates, etc., and which often are quite devoid of crystal form. By carefully transferring any certain grain to a surface of unglazed porcelain and crushing it with a hard object there is obtained a powder which, when rubbed fine, may have a distinctive colored streak which will prove of diagnostic value. The presence of uranium or thorium in any appreciable quantity in any of the minerals can be shown by sprinkling some of the sand on a fresh photographic plate which is well wrapped in light-proof paper and allowing it to stand undisturbed for a week or more. When the plate is developed, the presence of radioactive minerals is shown by small clouded exposed spots on the resulting negative varying in intensity with the size of the particle and its degree of radioactivity which is directly proportionate to its content of uranium or thorium.

Methods of goniometric study on such minute crystals can be applied only by a crystallographer with improved apparatus and to grains or crystals having bright faces. The results are usually conclusive, but unfortunately this is not invariably the case. In the

present study it was found impossible to determine whether many tetragonal crystals were zircon, rutile, xenotime, or thorite by crystallographic measurements. The angles of the commonly occurring pyramids on these minerals are more closely similar than the measurements usually obtained from adjacent faces of the same crystal. This may be shown by comparing the angle from the pole to the unit pyramid on each of these minerals as given below:

Theoretical angles of similar tetragonal minerals.

Zircon	$c(001) \wedge p(111) = 42°\ 09'$.
Thorite	$c(001) \wedge p(111) = 42°\ 10'$.
Xenotime	$c(001) \wedge z(111) = 42°\ 12'$.
Rutile	$c(001) \wedge s(111) = 42°\ 19'$.

The spectroscope is of very doubtful value in distinguishing between these troublesome tetragonal minerals because of its predominantly qualitative character. A crystal of either of the four minerals mentioned above will ordinarily yield spectroscopic reactions for the essential constituents of each of the others. The microspectroscope is open to the same serious objection.

The following table is put forth in the hope that it will be of service in aiding in the identification of some of the commoner constituents of black sands, especially when used in conjunction with the descriptions and figures of the following pages. The determinative table is almost entirely confined to the minerals observed during the examination of some 50 sands from Idaho localities, and there are very numerous others which might reasonably be expected to occur in heavy residues of this sort. When the sands of any region are found to have any important content of any unusual looking or unidentifiable minerals they should be submitted to a competent mineralogist for study.

Table of visible properties of minerals occurring in heavy sands.

- Extracted by a common magnet:
  - Color black:
    - Form isometric (octahedrons, etc.); magnetite.
    - Form trigonal (hexagonal and triangular, tabular); ilmenite.
    - Form broken or irregular; magnetite, ilmenite.
  - Color white to gray, opaque, metallic; platinum metals.
- Not extracted by a common magnet:
  - Opaque or nearly so:
    - Color black:
      - Form trigonal; ilmenite.
      - Form isometric; chromite (streak brown), limonite (streak brown), hematite (streak red).
      - Form tetragonal, prismatic:
        - Crystals dull; tapiolite (?).
        - Crystals brilliant, striated; rutile.

Not extracted by a common magnet—Continued.
- Opaque or nearly so—Continued.
  - Color black—Continued.
    - Form orthorhombic, prismatic, or tabular:
      - Crystals brilliant; columbite.
      - Crystals dull, pitted; samarskite.
      - Crystals with light external coating; polycrase.
    - Form monoclinic, prismatic:
      - Crystals vitreous, sharp; allanite.
      - Crystals frayed to fibrous; hornblende.
    - Form broken or irregular; limonite, hematite, ilmenite, tapiolite, cassiterite, rutile, columbite, samarskite, polycrase, uraninite, etc.
  - Color gray to white, luster metallic:
    - Grains malleable; platinum metals.
    - Grains brittle; arsenopyrite.
  - Color yellow, luster metallic:
    - Grains clear yellow, malleable; gold.
    - Grains pure yellow, brittle; chalcopyrite.
    - Grains greenish yellow, brittle; pyrite.
- Transparent to translucent:
  - Color red:
    - Deep red to nearly black, form prismatic or irregular; rutile.
    - Light rose to brownish red:
      - Form isometric; garnet.
      - Form tetragonal; zircon.
    - Color brownish to vermilion red or grayish, translucent to nearly opaque, form irregular; cinnabar.
  - Color yellow:
    - Pale yellow to greenish yellow:
      - Form monoclinic, flat; titanite.
      - Form orthorhombic, prismatic; olivine.
      - Form broken or irregular:
        - Luster greasy; titanite, scheelite.
        - Luster vitreous; olivine.
    - Amber yellow to brownish yellow:
      - Form monoclinic:
        - Habit prismatic or equidimensional; monazite.
        - Habit pyramidal, very flat thin; titanite.
      - Form broken or irregular:
        - Luster resinous; monazite.
        - Luster greasy; titanite.
        - Luster dull; scheelite.
  - Color green:
    - Deep green to dull green, form prismatic, frayed, or fibrous; hornblende.
    - Bright green to yellow green and yellow:
      - Form orthorhombic, prismatic; olivine.
      - Form monoclinic:
        - Habit thin, flat; titanite.
        - Habit prismatic:
          - Luster resinous; monazite.
          - Luster vitreous; augite.

Not extracted by a common magnet—Continued.
  Transparent to translucent—Continued.
    Color green—Continued.
      Bright green to yellow green and yellow—Continued.
        Form broken or irregular:
          Luster vitreous; augite, olivine.
          Luster greasy; titanite.
    Color blue of various shades, varying to lavender and gray:
      Form hexagonal; corundum.
      Form bladed; cyanite.
    Color gray to brownish gray:
      Form tetragonal; zircon.
      Form isometric, rounded; pyrochlore (?), microlite (?).
      Form broken thin chips, glassy; obsidian.
    Color white or colorless (varying to smoky or faintly pink):
      Form isometric; diamond.
      Form hexagonal (prismatic or pyramidal); quartz.
      Form tetragonal, various; zircon.
      Form monoclinic, prismatic; monazite.
      Form broken or irregular:
        Luster vitreous; quartz.
        Luster adamantine; zircon.
        Luster resinous; monazite.

The sands studied, about 50 in number, were those preserved in the United States National Museum reference collections. These have been accessioned from various sources, but mainly by transfer from the United States Geological Survey, most of which are those examined by Day in the work cited below. A few are sands received from miners or prospectors for examination and report which have been of sufficient general interest to deserve preservation. The sands in most cases are not accompanied by data as to how they were concentrated or what processes they have been subjected to in the laboratory since they were collected. It seems certain that almost all have been more or less worked over by screening, gravity, and magnetic concentration, and that some are merely fractional portions of the original sand which have been separated by one of the above processes. It is therefore impossible to surmise, in most cases, the quantitative amounts of the several minerals originally present. Thus, it is not known whether the predominance of ilmenite over magnetite, commonly shown in the samples, is actual or due to the magnetite having in large part been extracted by a magnet. Similarly, some samples show considerable amounts of gold, while others, which from their nature and locality might be expected to be highly auriferous, contain none, the natural inference being that this metal has been removed by amalgamation.

The localities represented by samples in the collection studied are not as scattered as might be considered desirable, the sands, with a few exceptions, falling into three groups, the first from the bars of

the Snake River; the second from the gold placer region of the Boise Basin, and the third from the placer-mining region centering about Pierce City, in Clearwater County.

The source of the minerals occurring in the sands of the bars of Snake River is somewhat problematical. Very fine gold is known to occur in these sands throughout the length of the river and many attempts have been made to work the deposits, but, owing to the extremely fine state of subdivision of the metal, these efforts have not met with much success. The occasional olivine and abundant augite in the sands may be derived from the basaltic lava which covers hundreds of square miles of the upper Snake River Valley or may have been concentrated from earlier sedimentary deposits derived from older formations in the foothills. It is noteworthy that the black sand from Minidoka, which contains a higher proportion of augite and more olivine than any other examined during the present investigation, was shown by Day[1] to contain appreciable amounts of platinum. Bell[2] has discussed the occurrence of platinum in the fine sands of the Snake River and has shown that it is not present in commercial amount.

The minerals found in the heavy sands of the Idaho Basin are probably all derived from the granitic rock which underlies the region or from the dikes of several types which intrude the granite. The placer districts of Clearwater County are largely derived from the rock of the northern extension of the same granitic batholith. The magnesium minerals, pyrope garnet, and augite, which occur in some sands from the latter section, are in all probability derived from local intrusions of basic magnesian rocks.

The minerals identified in the sands studied are described in some detail below, since the exact form and character of the constituent minerals of such sands have not heretofore been adequately set forth. The numerous figures accompanying these descriptions have been drawn from actual measurements made on crystals selected from the sands. The isometric forms of garnet, magnetite, and pyrite are not figured, as the habits of these minerals in the sands are precisely those illustrated by the figures given of these minerals in any standard textbook of mineralogy. It is hoped that the figures reproduced here may be of some assistance to future workers in identifying the minerals of such heavy sands under the microscope.

ILMENITE.

Ilmenite is abundant in the heavy sands, probably being present in excess of magnetite in all of those examined except in one from

[1] Day, David T., and Richards, R. H.. Mineral Resources U. S. for 1905, U. S. Geol. Survey, 1906, p. 1195.

[2] Bell, Robert N., Mining Industry of Idaho for 1906, p. 116, Ann. Rept. State Inspector of Mines, Boise, 1907.

Bear Creek, in Camas County. In part the mineral occurs in irregular grains, and it can not then be distinguished from similar grains of numerous other opaque black minerals. The majority of the ilmenite is in more or less distinct tabular crystals which are hexagonal-trigonal in form. In the monazite-bearing sands of the Boise Basin and the Clearwater region ilmenite is present in amount greatly in excess of magnetite. Here this mineral occurs in fine to coarse grains, which are, for the most part, distinctly tabular in form with three or six sided bright basal pinacoids present although the edges are dull or etched and rarely show good crystal faces. Often the basal pinacoid shows triangular markings which are very characteristic. A typical crystal is shown in the orthogonal and perspective drawings of figure 27. The angles measured on a crystal similar to this are given below:

Angles of ilmenite crystal from Rhodes Creek, Pierce City district.

Letter	Miller.	Reflection.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
c	0001	Very good..	0 00	0 00	0 00	0 00
p	$11\bar{2}1$	Good......	30 00	57 51	30 00	57 58
	$\bar{1}122$	Very poor..	29 54	38 18	30 00	38 38
a	$10\bar{1}0$	...do.......	0 46	90 00	0 00	90 00

Although the general aspect does not differ greatly, the forms present vary somewhat from crystal to crystal. A second crystal measured gave the following forms and angles:

Angles of ilmenite crystal from Idaho City.

Letter.	Miller.	Reflection.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
c	0001	Very good..	0 00	0 00	0 00	0 00
u	$50\bar{5}1$	Very poor..	0 00	72 50	0 00	77 46
	$\bar{2}241$	Very good..	29 29	72 50	30 00	72 38
K	$41\bar{5}1$	Poor.......	11 38	76 58	10 53	76 42

The ilmenite of the monazite sands, which is in all probability derived, as are the associated monazite and zircon, from the granitic rock of the Central Idaho batholith, is not attracted to a magnet. In the fine sands of the Snake River about one-half of the total amount of black iron ore is extracted by a magnet, both the nonmagnetic and the magnetic portions being composed of irregular black grains and disseminated brilliant thin tabular crystals of ilmenite. Only

rarely does a magnetic grain show the typical octahedral form of magnetite, and it may be that the black mineral is practically all ilmenite. The ilmenite of the Snake River sands thus is in considerable part magnetic as contrasted with the nonmagnetic character of the same mineral in the sands of the granite regions.

The source of this mineral in these fine sands of the Snake River is not certain. It is noteworthy, however, that the thin sections of the diabasic rock, which occurred abundantly in sand from Minidoka, contained numerous scattered tabular crystals of ilmenite, as noted under "augite."

GARNET.

Garnet is almost if not quite invariably present in the sands examined, occurring either as grains, irregular fragments, or rough to highly perfect crystals. As seen under the binocular this mineral is of two varieties, which are distinguished by a very striking difference of color. The most abundant and widely distributed variety is clear bright red to slightly brownish red in color and is probably almandite. It occurs most abundantly in many of the sands, being especially prominent in those which carry abundant monazite, as in samples from Centerville, Idaho City, and other localities in Boise County. Here it is in part in small, irregular worn, or broken grains, but for the most part the grains are small, highly perfect limpid and transparent crystals which are either trapezohedrons, dodecahedrons, or combinations of the two. In the sand from Bear Creek almandite garnet occurs in rare small model-perfect crystals up to a millimeter in diameter, associated with titanite and allanite. In the fine sands of the Snake River similar brown-red almandite is present in subordinate amount as small irregular grains. The abundant garnet of these sands is rather pale rose pink in color when in small grains. This pink garnet is present in greater or less amount in every Snake River sand examined, in some cases being the only garnet present, while in other sands both varieties occur. Aside from the Snake River samples pink garnet was noted only in a few sands from the vicinity of Pierce City and Orofino, in Clearwater County. In some of the coarser sands from these latter localities the garnet occurs in masses up to 1 centimeter in diameter, and in the larger grains its color is rose purple, being comparable to that of the rhodolite garnet from North Carolina. The pink or purple variety in the heavy sands is more or less coincident in occurrence with augite, and this fact, together with its color and general appearance, supports the conclusion that it is probably a magnesian variety, high in the pyrope molecule. As contrasted with the abundant and highly perfect crystals of the brown-red garnet, the pink variety rarely occurs in recognizable crystals, being usually in water-worn grains or angu-

lar broken fragments. Such few crystals as were seen were much rounded, with deeply striated and pitted faces, the forms being but dimly distinguishable.

MAGNETITE.

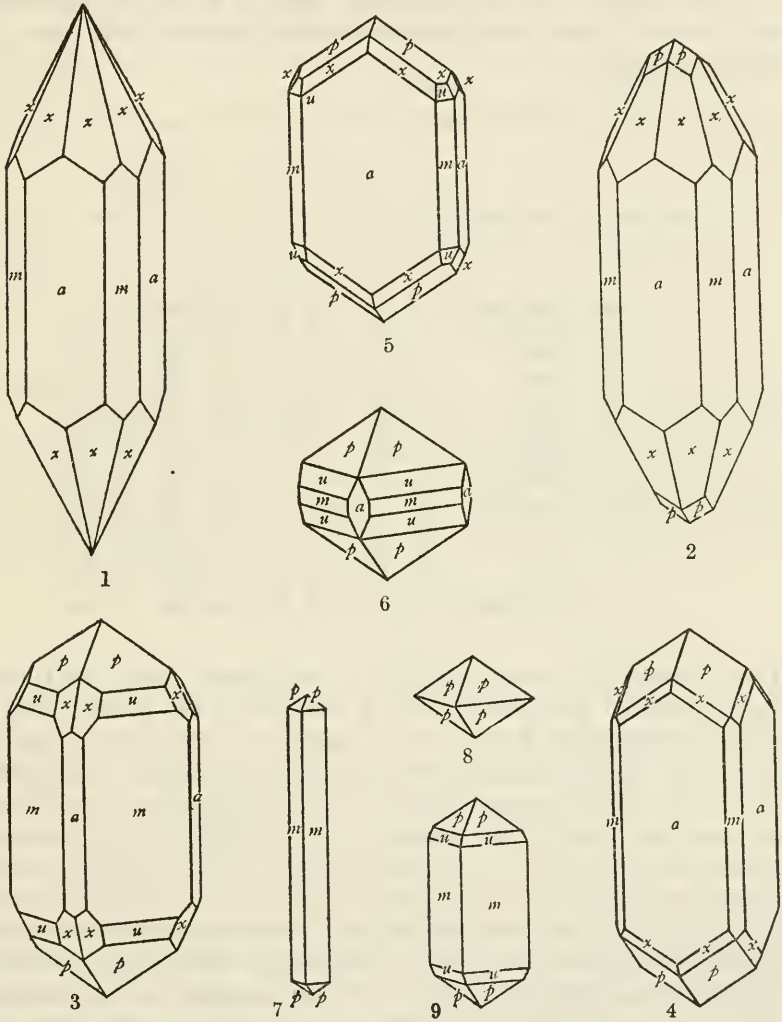
Magnetite is much less abundant in the materials examined than it is in black sands from most localities. In the lot from Camas County magnetite in irregular grains and octahedral crystals is the most abundant constituent, making up approximately four-fifths of the whole, but this is the only example found in which magnetite is present greatly in excess of ilmenite. The fine sands from the Snake River contain varying amounts of black iron ore up to about 30 per cent. This is in large part in irregular dull-black grains and it is not possible to determine in what part these grains are magnetite. About one-half of the total amount of black material is removed by a magnet. When this magnetic portion is examined it is found to consist mainly of rough irregular grains with occasionally a brilliant black tabular crystal of ilmenite. Other crystals of ilmenite are nonmagnetic. Rarely the magnetic material shows octahedral crystals of magnetite. Magnetite is present in negligible amount in the many monazite-bearing sands of the Boise Basin and of the Pierce City region, the black mineral being almost entirely ilmenite, which in these sands is not attracted to a magnet. Where the magnetite is in distinct crystals, it is in the form of octahedrons, which may be more or less distorted. In some coarse sands the magnetite is in small fine granular masses and in rare cases this mineral forms pseudomorphs after well defined pyrite crystals.

ZIRCON.

One of the most interesting and widespread constituents of the heavy sands is zircon, which occurs in greater or less amount in every sand examined. Ordinarily the mineral is clear and colorless, and it is invariably in beautifully sharp crystals, most of which are very transparent and brilliant. It occurs in considerable amount in the sands from the gold placers of the Boise Basin, where it is associated with monazite, but it is still more abundant, according to Lindgren,[3] in some placer districts, notably those near Florence and Warren, where the heavy residues are called "white sand" because of its presence. While commonly colorless, the zircon in the sands of the granite region varies from smoky gray to pale flesh red. The smoky crystals are much like smoky quartz in appearance and the color is often unevenly distributed. Inclusions are frequent, the most highly transparent and brilliant forms containing minute spherical

[3] Lindgren, Waldemar, U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 234, 1899.

bubble-like cavities and also minute microlite-like prismatic crystals of a transparent colorless mineral having a lower index of refraction than the zircon. Many of the translucent smoky-gray crystals appear to owe their color to minute inclusions of iron oxide. In form the zircons are most frequently prismatic, with the length three or four times the diameter, and the most abundant types show the first order



FIGS. 1–9.—CRYSTALS OF ZIRCON.

prism $m(110)$ and the second order prism $a(100)$ in almost equal development and are terminated by the ditetragonal pyramid $x(311)$, either alone (fig. 1) or together with the unit pyramid $p(111)$. Crystals of these habits are by far the most abundant in the monazite-bearing sands and also occur, though in lesser amount, in all

other sands examined, including the monazite-free samples from numerous localities along Snake River and the titanite and allanite bearing sand from Bear Creek. While, except as before mentioned, these crystals are usually colorless, a sand concentrate consisting largely of monazite, from Idaho City, contains abundant zircons of this form, which are yellow, being very like the monazite in color. A typical crystal, having this habit, from a monazite concentrate from Grimes Creek near Centerville was measured and gave the following angles:

Angles of zircon crystal from Centerville (fig. 2).

Letter.	Miller.	Reflection.	Measured.				Calculated.			
			φ		ρ		φ		ρ	
			°	′	°	′	°	′	°	′
a	100	Very good..	0	00	90	00	0	00	90	00
a	100	Medium....	0	01	90	00	0	00	90	00
a	100	Good......	0	08	90	00	0	00	90	00
a	100	Poor.......	0	11	90	00	0	00	90	00
m	110	Fair........	44	50	90	00	45	00	90	00
m	110	Good......	44	47	90	00	45	00	90	00
m	110	Poor.......	45	07	90	00	45	00	90	00
x	311	Medium....	18	38	63	19	18	26	63	43
x	311	Good......	19	31	64	03	18	26	63	43
x	311	Very poor..	17	59	64	03	18	26	63	43
x	311	Very good..	18	12	64	19	18	26	63	43
x	311	...do.......	18	27	63	44	18	26	63	43
x	311	...do.......	18	02	63	29	18	26	63	43
x	311	Very poor..	18	20	63	29	18	26	2	43
x	311	Very good..	18	25	63	05	18	26	2	43

The crystals vary considerably in development from the typical forms illustrated in figures 1 and 2, the first order prism being in some cases the larger form with its angles truncated by the second order prism (fig. 3), while in other crystals the relative development of the two prisms is reversed (fig. 4). The terminations vary also in some cases the ditetragonal pyramid x(311) being merely truncated at its extreme summit by the pyramid p(111), while in other crystals the unit pyramid p(111) is largely developed reducing the ditetragonal pyramid to mere line faces (fig. 3). Not infrequently these two extremes are observed to opposite ends of the same crystal yielding a peculiarly hemimorphic aspect. Some variants in the common development are difficult to orient, as, for instance, when the adjacent faces of the form x(311) are very unequally developed and reduce the prism faces to irregular polygons of small size. The pyramid u(331) is occasionally present as small faces which are dull and irregular and give poor measurements. A coarse-screened portion of a sand from Idaho City consisting largely of ilmenite contained

translucent crystals of zircon of two types, both of which are somewhat different from the normal transparent crystals occurring in finer screenings of the same lot of sand. The most abundant of these two types is peculiarly tabular to a face of the second order prism *a*(100), as shown in figure 5. The average angles obtained upon measurement of a crystal of this type are given in the following table:

Average angles of tabular crystal of zircon from Idaho City.

Letter.	Miller.	Reflection.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
a	100	Poor.............	0 13	90 00	0 00	90 00
m	110	.....do...........	45 07	90 00	45 00	90 00
p	111	Very good........	45 03	42 06	45 00	42 09
u	331	Very poor, approximately....	47 00	69 07	45 00	69 47
x	311	Very poor........	18 19	63 16	18 26	63 43

Other crystals from the same lot have a short pyramidal habit with *p*(111) prominent and *u*(331), *m*(110), and *a*(100) about equally developed, as shown in figure 6. These are irregular and appear as though made up of numerous very small individuals in parallel position. The reflection from the faces are consequently not very good. The angles measured on a crystal of this habit are given below.

Angles of zircon crystal from Idaho City (fig. 6).

Letter.	Miller.	Reflection.	Measured.		Calculated.	
			ϕ	ρ	ϕ	ρ
			° ′	° ′	° ′	° ′
m	110	Very good..	45 00	90 00	45 00	90 00
a	100	Good.......	0 02	90 00	0 00	90 00
p	111	Medium....	45 00	41 58	45 00	42 09
u	331	Fair........	45 00	69 29	45 00	69 47

Although the majority of the tetragonal crystals in the Snake River sands are similar to those shown in figures 1 to 4, several other types were seen. A sand from Rosa, Bingham County, contains scattered translucent crystals of a brownish color which are short prismatic, with the length about twice the thickness. These show the prism *m*(110) and the pyramids *p*(111) and *u*(331) developed as shown in figure 9. A crystal of this type yielded the following measurements:

Angles of zircon crystal from Rosa, Bingham County (fig. 9).

Letter.	Miller.	Reflection.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
m	110	Good......	45 00	90 00	45 00	90 00
p	111	Poor.......	45 00	42 20	45 00	42 09
u	331	Very poor..	45 00	70 11	45 00	69 47

This looks very much like zircon, but the angles are nearer those of rutile, although the measurements are not sufficiently exact that it may be referred to that mineral. One or two crystals having the same form as the last and an orange-red color were seen in a sand from Minidoka but were not measured. One of the most unusual types of tetragonal crystals seen occurs in the Minidoka sand and is long acicular, the length being 10 to 20 times the diameter. These crystals show only the unit prism *m*(110) and the pyramid *p*(111), as shown in figure 7. The crystals of this long prismatic type are all pale pink in color. One which was measured gave the following angles:

Angles of zircon crystal from Minidoka (fig. 7).

Letter.	Miller.	Reflection.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
m	110	Very good..	45 00	90 00	45 00	90 00
p	111	...do.......	45 00	42 00	45 00	42 09

The only other type of tetragonal crystals seen was bipyramidal showing no prism faces, only the form *p* (111) being present. This habit is illustrated by figure 8. Crystals of this habit having an orange-red color occurred rarely in a sand from Snake River in Ada County and a few having a brownish-white color were seen in the samarskite-columbite concentrate from Idaho City. Accurate measurements could not be obtained from these crystals owing to their small size and imperfect faces.

While all of the above-described tetragonal minerals are referred to zircon, comparison of the angles will show, as previously mentioned, that several of the types, especially the latter less common ones which have orange or brown colors may equally well be thorite, xenotime, or a light-colored rutile. The measurements were in no case sufficiently accurate or dependable to serve as evidence for differentiating between these tetragonal minerals which differ only a few minutes from each other in angles. It is comparatively certain, however, that zircon is the only abundant tetragonal mineral pres-

ent in the sands examined and that, if these similar minerals occur at all, it is only as rare and scattered crystals.

MONAZITE.

The presence of monazite in heavy sands in Idaho was first recognized by Lindgren [4] in the gold placers of the Boise Basin, where he found it as a resinous brown mineral in subangular grains in part exhibiting crystal faces. Roughly quantitative analyses by Hillebrand made upon the purified sand showed the principal constituents to be phosphoric acid and cerium earths, with a small amount of thorium. The absence of yttrium earths showed that xenotime probably was absent. Later, Day in his work on the black sands of the Pacific Slope,[5] reported the mineral from 37 localities in 10 counties in Idaho. Some of these are in error, since several of the sands listed are from Snake River localities and a reexamination of the same samples failed to detect any monazite. Schrader [6] has recently described the occurrence of monazite in Nez Perce County in northern Idaho.

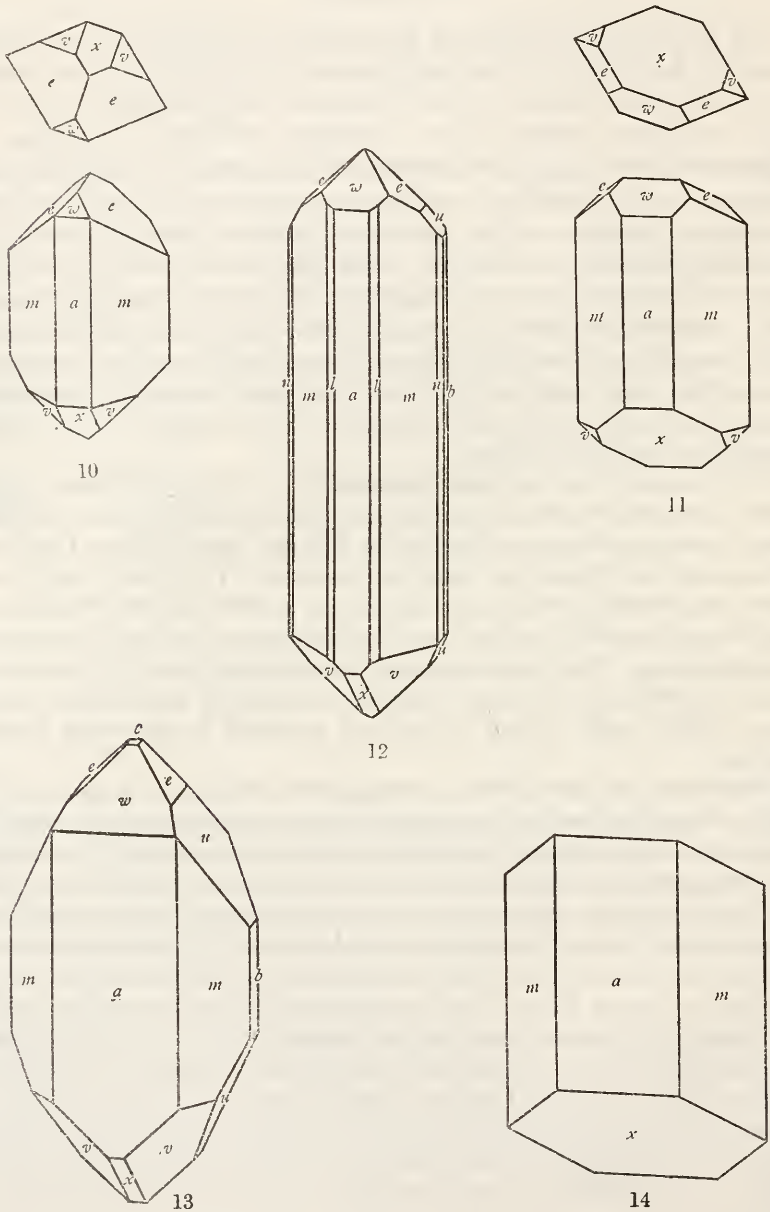
The monazite occurs most abundantly in the gold-placer region about Centerville, in Boise County, and preparations were made some years ago by the Centerville Mining and Milling Company to recover and clean the sand for market. The plant which was built was burned before any important production had been made and the commercial outlook was not sufficiently bright to encourage its rebuilding. The Idaho monazite is seemingly lower in its content of thoria, which is the only valuable constituent, than similar sands from Brazil, with which it can not compete in the very limited market.

The work of the several investigators who have examined the Idaho monazite-bearing area seems to indicate conclusively that the monazite is an original mineral present as an accessory constituent in the granitic rock of the great central Idaho batholith and it is probably more or less present in every drainage basin within this great granitic area. Lindgren panned crystals of both monazite and zircon from angular granite soil formed by disintegration of the granite on slopes where these minerals could have no other source.

During the present examination monazite was noted abundantly in sands from Grimes Creek and elsewhere near Centerville and from Idaho City, in Boise County, from Pierce City and Orofino, in Clearwater County, and from French Creek, in Nez Perce County. It is a noteworthy fact that in the examination of Snake River sands from nine localities in five counties no trace of the mineral was found.

[4] Lindgren, Waldemar, U. S. Geol. Survey, 18th Ann. Rept., pt. 3, pp. 677–679, 1898.
[5] Day, D. T., and Richards, R. H., Mineral Resources U. S. for 1905. U. S. Geol. Survey, 1906, pp. 1195–1201.
[6] Schrader, F. C., Bull. U. S. Geol. Survey No. 430, p. 185, 1910.

In color the monazite is commonly resinous golden yellow to amber or orange brown. Only a few crystals were found which had what could accurately be described as a greenish tinge, the associated



Figs. 10–14.—Crystals of monazite.

greenish grains usually being either augite, titanite, or olivine. A few green and a few perfectly colorless transparent monazite crystals were seen in the samarskite-columbite concentrate from

Idaho City described below. The monazite is, for the most part, in sharp and perfect crystals although many of the larger crystals are broken or abraded. The average diameter in the mineral in the screened sands studied is less than 1 mm., but in one "oversize" sample rough crystals up to 5 mm. in diameter were observed, and larger masses may have been discarded by screening. In form the monazite from all of the several localities represented is very similar. The figures reproduced were all drawn from measurements made upon crystals selected from a sand from Centerville, and subsequent examination of the numerous other sands did not reveal any additional forms, combinations, or habits. The smaller crystals are often flawless and perfectly transparent, while the larger individuals are more or less opaque from the presence of numerous cracks and rifts. The forms noted on the crystals are few in number and perhaps 90 per cent of the crystals seen had almost precisely the habit shown in figure 10, and 9 per cent had the form shown in figure 11. Figures 12, 13, and 14 represent quite unusual habits. The very simple habit shown in figure 14 is characteristic of some of the very largest as well as of the colorless and green monazite crystals seen in the samarskite concentrate. The more prominent faces on the majority of the crystals gave fairly good reflections and the agreement between the angles measured and the theoretical angles completely dissipates any doubt which may remain regarding the identity of the Idaho mineral. The averages of the angles measured on the several crystals examined are compared with the theoretical angles in the following table:

Angles of monazite from Idaho.

Letter.	Miller.	Reflection.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
a	100	Very good..	90 00	90 00	90 00	90 00
b	010	.....do.....	0 00	90 00	0 00	90 00
c	001	Very poor..	89 58	13 23	90 00	13 40
m	110	Very good..	46 44	90 00	46 43	90 00
n	120	Good......	27 35	90 00	27 58	90 00
l	210	Very poor..	69 15	90 00	64 47	90 00
e	011	Good......	14 25	43 37	14 43	43 44
w	101	Very good..	90 04	50 43	90 00	50 48
v	$\bar{1}11$	Good......	38 43	49 43	38 37	49 50
u	021	Very good..	7 36	61 38	7 29	61 49
x	$\bar{1}01$	.....do.....	90 09	36 31	90 00	36 29

The monazite of one sample from Pierce City is in unusually coarse, imperfect crystals which have an internal grating structure which may be due to multiple or polysynthetic twinning. Inclusions are not abundant, and the monazite is rarely attached to any other mineral. In one case a hexagonal tablet of biotite was seen imbedded

in a crystal and another crystal was penetrated by a tabular crystal of ilmenite.

TITANITE.

Titanite is not rare as a constituent of the heavy sands, although it is nowhere very abundant and its distribution is not so universal as might be expected. It occurs in the nonmagnetic portion of the sand from Bear Creek, Camas County, along with zircon, allanite, and gold, as small irregular grains and flat crystals which vary from yellow through various shades of green in color. Except for a certain greasy appearance and luster the irregular grains are hard to distinguish from irregular grains of augite and olivine which are common in other sands. The majority of the titanites, however, show some crystal faces, and the form is quite characteristic, being unmistakably different from the forms assumed by olivine and augite. The titanite crystals show the familiar "envelope" combination of the base $c(001)$, the clinopinacoid $a(100)$, and the unit pyramid $n(111)$, the appearance of the crystals being as shown in the drawing, figure 26. Usually the thin edges and corners of the crystals are more or less worn and broken, and where this is not the case the interfacial angles often have a rounded or fused appearance. The basal pinacoid is usually irregular or dull and pitted. The angles measured by which the several forms were identified are as follows:

Interfacial angles of titanite from Bear Creek, Camas County.

Angle.	Reflections.	Measured.		Calculated.	
		°	′	°	′
$n(111)\wedge n(111)$	Very good∧very good	43	38	43	49
$n(111)\wedge n(111)$	do	43	32	43	49
$c(001)\wedge a(\bar{1}00)$	Very poor∧poor	120	21	114	03

Flat crystals of this same form are abundant also in a sand from Cow Creek, in the Pierce City district, which contains much ilmenite with rose-pink pyrope in much-rounded crystals, and some monazite. It also occurs in small amount in most of the monazite-bearing sands of the Boise Basin region. In these latter sands the titanite has a pale-brown color not very different from the color of the monazite. It may be distinguished from the monazite by differences in luster and crystal form.

SAMARSKITE.

A sample of a heavy concentrate from a sand from Idaho City ("P654, olivine") was found to be distinctly radioactive. Careful microscopic examination showed this material to be composed in large part of a coal-black glassy mineral with a brown streak and conchoidal fracture. The mineral occurs in rounded grains and in

dull pitted square prismatic crystals which are either broken at the ends or are terminated by a chisel-shaped dome. All of the grains and crystals are very much corroded and are dull and brownish in color on the outside. One of the smoothest of the crystals was measured by reflected light from the faces and gave approximate measurements of 90° between the pinacoids and 86° between the faces of the dome, which compares well with the angle $e(101) \wedge e'(\bar{1}01)$ 87° for samarskite. The radioactivity of the mineral, its crystal form, and its physical properties suggest that it is samarskite. The identity is by no means definitely established, however, and it is to be understood that this and several other of the rare-earth minerals of these sands are but tentatively referred to the species under which they are described. The hardness of the samarskite is 5–6. The streak is dark brown. When powdered and examined under the microscope the mineral is found to have a dark-brown color and to be transparent on very thin edges. It is isotropic throughout, as are most such rare-earth minerals. The form and appearance of the crystals are as shown in figure 15, which also shows the tendency of two or more crystals to occur in parallel position. The samarskite makes up about 60 per cent of this material, which apparently is the heaviest fraction of a concentrate from a sand obtained from a dredge operating at Idaho City. In addition to the 60 per cent of samarskite, this concentrate contains about 10 per cent of columbite in sharp crystals, the remaining 30 per cent consisting of various other unidentified rare-earth minerals, zircon, monazite, garnet, and much metallic lead, the latter evidently being fragments of solder, babbitt, or of lead bullets. Quartz is frequently attached to the samarskite, and in a few instances what appears to be monazite is intergrown with it. Several other samples which were labeled "P654 chromite," "P654 garnet," etc., are apparently other fractional concentrates from the same original lot of sand. The one labeled "garnet" consists of about 50 per cent by volume of pale to deep brownish-red almandite in sharp trapezohedral crystals, the remaining 50 per cent being largely samarskite and columbite. The columbite is relatively more abundant than in the first sample examined. The samarskite is entirely like that already described, showing rounded pitted grains and rough crystals. Some of these have grains of quartz and crystals of muscovite attached to them, while others seem to show either two minerals or two generations of samarskite, some of the grains, where broken, showing an inner crystal surrouned by an outer shell of a similar substance. The sample

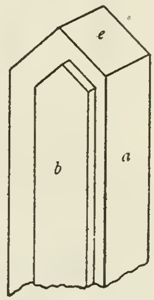
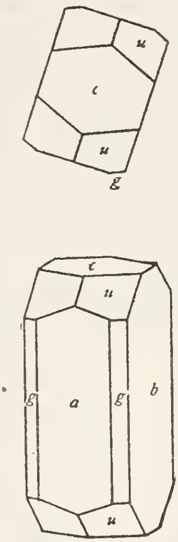


Fig. 15.—Crystal of samarskite (?) from Idaho City.



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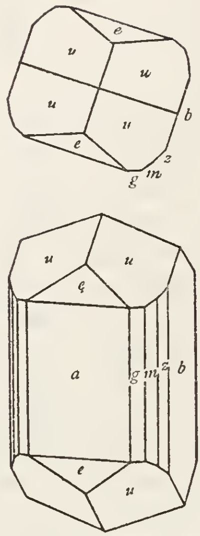

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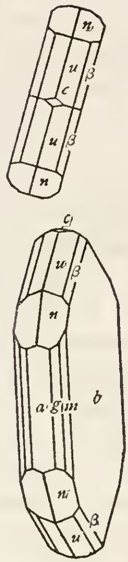

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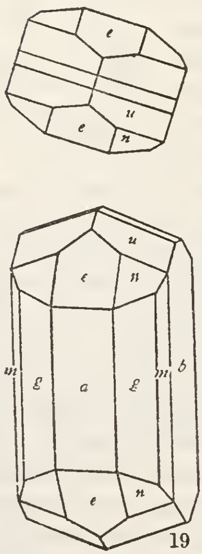

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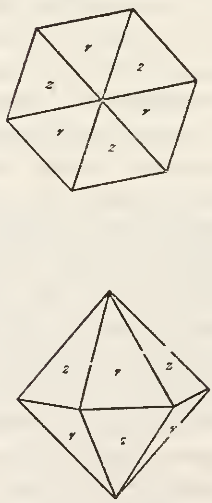

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21

FIGS. 16–21.—16–19, COLUMBITE FROM IDAHO CITY; 20 QUARTZ, AND 21, AUGITE FROM SNAKE RIVER.

labeled "chromite" contains a little samarskite, but is for the most part composed of ilmenite.

COLUMBITE.

The samarskite concentrate from Idaho City described above contains important amounts of a mineral in black crystals which proved, upon measurement, to have the angles of columbite. Aside from the difference in form, which is not always manifest, this mineral greatly resembles ilmenite, which occurs commonly in the sands. The columbite makes up about 10 per cent of the high samarskite sand and is more abundant than samarskite in the garnet-bearing sand. The crystals vary considerably in habit, ranging from tabular parallel to the pinacoid *b*(010) to square prismatic. The common forms and habits are illustrated in the drawings (figs. 16 to 19, inclusive). The color is black, and the luster is more vitreous than metallic. The prismatic planes are usually very brilliant, but the terminal faces are frequently more or less dull and pitted. This is especially true of the unit pyramid *u*(111), the faces of which are most frequently dull and often show rounded depressions. Under the microscope the powdered mineral is translucent on thin edges, with a brown color. Frequently several similar crystals are grown together in parallel position and many crystals are attached to small masses of quartz and muscovite. In the coarse polycrase-bearing sand from Centerville crystals up to 1 cm. in length occur sparingly which have the form and appearance of columbite. These are invariably dull with a grayish-black color and more metallic luster. They also are more opaque than those described above. Judging from appearance alone it seems probable that these crystals from Centerville are more nearly pure iron columbate, while the brilliant black crystals from Idaho City are probably higher in their content of tantalic acid, and possibly they contain some manganese. The forms and angles measured on crystals from Idaho City are given in the following table:

Forms and angles of columbite from Idaho City.

Letter.	Miller.	Reflection.	Measured.		Calculated.	
			φ	ρ	φ	ρ
			° ′	° ′	° ′	° ′
a	100	Very good..	90 00	90 00	90 00	90 00
b	010	.....do.....	0 00	90 00	0 00	90 00
c	001	Poor........	0 00	0 06	0 00	0 00
g	110	Very good..	68 14	90 00	68 05	90 00
m	130	.....do.....	39 32	90 00	39 38	90 00
z	150	Poor........	28 20	90 00	26 26	90 00
u	111	Fair........	68 23	43 23	68 05	43 48
n	211	Good.......	78 35	61 16	78 37	61 09
β	121	Poor........	52 04	48 36	51 11	48 48
e	201	Good.......	90 00	60 29	90 00	60 39

POLYCRASE.

A sample of "oversize" coarse sand from Centerville contains abundant grains and rough crystals of a dark-brownish or greenish-black mineral not very different in appearance from the samarskite. The crystals, which reach 1 cm. in diameter, are orthorhombic in aspect and vary from square prismatic to thin tabular. They are all coated with an exterior crust of a pale-yellow alteration product. Within this shell the crystals and grains consist of a brownish-black glassy material having a conchoidal fracture and a brown streak. Under the microscope thin fragments are transparent, isotropic, and brown in color. The mineral is intensely radioactive. Mr. Frank L. Hess had previously recognized this or a similar mineral in placer gravels from Centerville, and recently has turned his sample over to the present writer for chemical investigation, which it is hoped may yet be undertaken. The properties and appearance of the mineral are identical in most respects with the polycrase from Marietta County, N. C., and for the present it will be referred to that mineral. This mineral, recognizable by its light-colored coating, occurs sparingly also in the samarskite and columbite bearing concentrates from Idaho City. A crystal from this lot gave measurements on the pinacoids and on two pyramid faces indicating roughly the form *s*(111) of polycrase. The remaining faces were coated. The form and appearance of this crystal, which was tabular, are shown in the drawing (fig. 22). There was, as shown in the figure, a smaller crystal in parallel position projecting from the face of the larger individual.

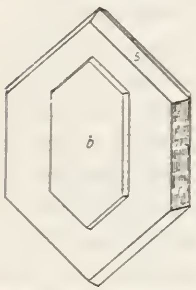


Fig. 22.—Crystal of polycrase (?) from Idaho City.

OTHER RARE-EARTH MINERALS.

In addition to the rare earth minerals described above under the headings "samarskite," "columbite," and "polycrase," it is probable that a number of others occur in lesser amount in the sands. In the columbite-samarskite material certain glassy to resinous grains without crystal form gave light-brown internal reflections and had a light-brown streak, while other grains gave green internal reflections and fragments were brownish green under the microscope. These may include euxenite and yttrotantalite or possibly fergusonite. One small crystal which was noted under the microscope appeared to have the tetragonal form and pyramidal hemihedrism of fergusonite. In the polycrase-bearing sand from Centerville, in addition to the abundant polycrase, there are occasional grayish iron-black tetragonal crystals having dull faces, which may be one of

the minerals related to tapiolite. Other grains appeared to be much worn isometric crystals of a brownish-gray color, resembling microlite or pyrochlore. When all the recognizable rare-earth minerals had been picked out of a sample of this sand, the residue was found to still be radioactive and to contain heavy opaque gray-black grains with submetallic luster.

PYRITE.

Unaltered pyrite was seen only as one or two grains in one sand, but pseudomorphs preserving the crystal form of pyrite perfectly are present in greater or less number in almost every sample of sand examined. These are often deceptively lustrous and black in color, with polished faces, but occasional particles in each sand are brownish in color or have an ocherous external coating. Most of the pseudomorphs consist of limonite, as is shown by their brown streak, but a few are attracted by a magnet and consist wholly or in part of magnetite. The forms exhibited by these pyrite pseudomorphs are cubes, or cubes with the corners truncated by octahedral planes in the majority of the sands, but those in monazite sand from Centerville are octahedral and are frequently much elongated and distorted. The most complex forms occur in the titanite and allanite bearing sand from Bear Creek. In this sand the altered pyrite crystals, which are abundant, show combinations of the cube, octahedron, and pentagonal dodecahedron, with possibly other forms. They would be exceedingly hard to identify by form alone were it not for the presence on all of them of the highly characteristic striations and grooves produced by oscillation between the cube and the pyritohedron. Altered pyrite crystals are sparingly present in all of the fine sands from Snake River and are very abundant in some of the coarser sands of the Boise Basin region.

ALLANITE.

Allanite was positively identified only in a sand from Bear Creek, in Camas County, although crystals of the same form and habit were noted in small number in several other sands, especially those from Minidoka and other Snake River localities. This mineral is difficult to distinguish by its form from certain prismatic black crystals of hornblende which occur occasionally. The Camas County sand consisted largely of magnetite, which, when extracted with a magnet, left a light-colored residue consisting mainly of irregular fragments of quartz. Scattered through this residue were crystals of titanite, zircon, garnet, etc., together with small black prisms with wedge-shaped terminations, which resembled augite crystals. One of these crystals upon being measured on the goniometer gave

approximately the angles of epidote, which suggested that it might be allanite. A crystal was accordingly crushed and embedded in an oil having an index of refraction of 1.695 and examined with a petrographic microscope, when it was found to be doubly refracting almost throughout and distinctly pleochroic in tones of pale dirty brownish green and greenish black. Its indices of refraction were all distinctly lower than that of the oil, suggesting that the mineral was allanite (n=1.68 Larsen) rather than epidote (n=1.73–1.77 Larsen). Since the identity and orientation of the crystal were not suspected when it was measured, the direction of elongation was mounted as polar. The angles measured are given below as interfacial angles.

Angles of allanite crystal from Camas County (fig. 28).

Angle.	Reflections.	Measured.	Calculated.
		° ′	° ′
$n\ (\bar{1}11) \wedge n\ (\bar{1}11)$	Good∧poor	70 54	71 35½
$c\ (001) \wedge a\ (100)$	Very poor∧poor	65 20	64 59
$c\ (001) \wedge a\ (100)$	Poor∧fair	65 32	64 59
$c\ (001) \wedge i\ (\bar{1}02)$	Fair∧maximum illumination.	37 19	34 15½
$a'\ (\bar{1}00) \wedge r\ (\bar{1}01)$	Poor∧fair	51 43	51 37

RUTILE.

Common red-black to deep-red rutile is unusually rare in these sands, the titanium being present mainly as ilmenite, with some titanite. Rare rounded prisms of deep-red rutile were found in a sand from Rhodes Creek, near Pierce City, and in a Snake River sand from Minidoka. A steely-lustered prismatic crystal 6 mm. long, found in the polycrase-bearing sand from Centerville, was identified as rutile. The prismatic zone is deeply striated, the forms present being a(100), m(110), and l(130). The crystal is terminated by the pyramid e(011). This crystal is shown in the drawing (fig. 23). It was peculiar in showing greenish internal reflections and when the crystal was crushed and examined in transmitted light the color was yellowish green, a very unusual color for rutile. As emphasized under "zircon," some of the light-colored crystals which have been described as that mineral may be rutile, the angles of rutile and zircon being so similar that very accurate measurements are necessary to distinguish between them.

AUGITE.

Augite is common in all of the Snake River sands examined and also occurs in lesser amount in several samples from Clearwater and Nez Perce Counties. It was not found in any of the sands from the

Boise Basin. This mineral coincides roughly in distribution with the rose-pink or purple variety of garnet referred to pyrope. In several Snake River sands augite is the most abundant ingredient. Those from Wapi and Minidoka especially containing 6 per cent or more of the mineral. The augite-bearing sands frequently contain more or less olivine in clear yellow crystals.

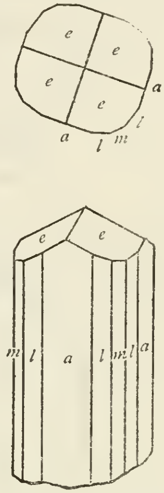


FIG. 23.—RUTILE CRYSTAL FROM CENTERVILLE.

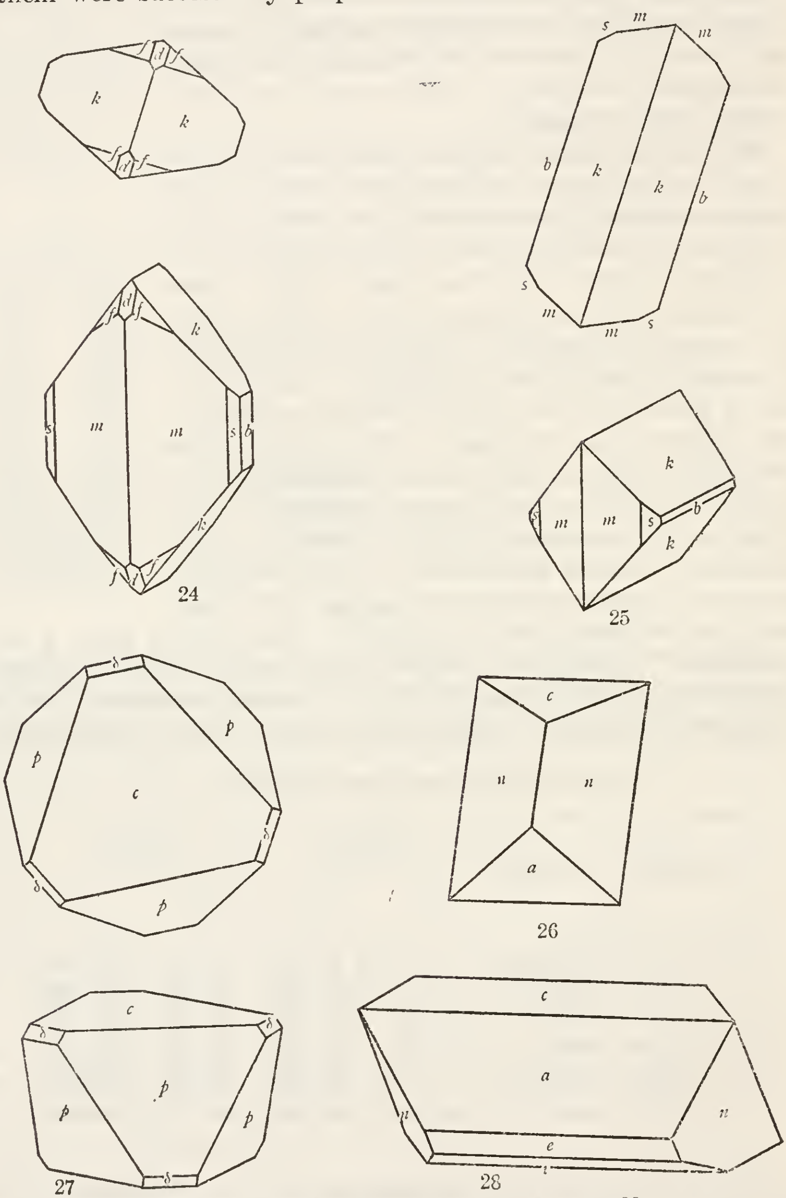
The augite occurs in irregular grains and imperfect crystals which vary from emerald green through various shades of pistachio and olive green in color. They are very similar in color to some of the titanite occurring in the sand from Bear Creek, Camas County, but differ in form and luster. The crystals are commonly prismatic in form and are etched and corroded so that, although bright and glassy, very few of them have faces which yield measurable signals. There is no cleavage visible and the glassy green grains and crystals were at first thought to be olivine. Careful search, however, revealed crystals which could be measured and these gave the angles of augite. The few measurable crystals found gave fairly good signals in the prism zone but the terminal faces are invariably etched and dull. One crystal gave a faint "schimmer" reading on a terminal face which indicated approximately the negative pyramid $s(\bar{1}11)$. The angles measured on this crystal which identify it as pyroxene are given in the following table:

Angles of augite crystal from Minidoka (fig. 21).

Letter.	Miller.	Reflection.	Measured.		Calculated.	
			ϕ	ρ	ϕ	ρ
			° ′	° ′	° ′	° ′
m	110	Very good..	43 27	90 00	43 33	90 00
m	110	Good......	43 52	90 00	43 33	90 00
m	110	Very good..	43 36	90 00	43 33	90 00
a	100	Poor.......	90 02	90 00	90 00	90 00
a′	$\bar{1}00$	Good......	90 12	90 00	90 00	90 00
b	010	...do.......	0 00	90 00	0 00	90 00
b	010	Very poor..	1 07	90 00	0 00	90 00
s	$\bar{1}11$	...do.......	28 54	33 30	25 07	33 04

Several of the coarser unscreened sands from Minidoka, which were rich in augite, contained small pebbles, the great majority of which were seen under the binocular to consist of a cellular gray rock containing glassy-green grains in a light gray ground. The

grinding of thin sections of these small pebbles, which averaged about 3 millimeters in diameter, was difficult, but about a half dozen of them were successfully prepared. These sections were all alike



FIGS. 24–28.—24–25, OLIVINE; 26, TITANITE; 27, ILMENITE; 28, ALLANITE.

and consisted of a fresh rock of marked ophitic texture having laths of twinned plagioclase feldspar in a ground of glassy augite. The sections also contained scattered comparatively large tabular crystals of ilmenite.

OLIVINE.

Olivine occurs sparingly in all of the sands from Snake River localities as clear pale-yellow angular grains. In several samples from Minidoka it is present as clear pale lemon-yellow crystals with highly lustrous faces. These resemble small topazes or crystals of chrysoberyl and their identity was not suspected until they were measured and found to have the angles of olivine. The dominant forms present are the prism $m(110)$ and the dome $K(021)$ with the prism $s(120)$ and the brachypinacoid $b(010)$ less prominent. The machrodome $d(101)$ and the pyramid $f(121)$ occur rarely as very small faces, as shown in figure 24. The combination of forms is the same on all of the crystals measured, but they vary in development, ranging from short prismatic parallel to the vertical axis (fig. 24) to moderately long prismatic by elongation on the a axis (fig. 25). Similar clear-yellow olivines from other samples of Snake River sands do not show measurable faces. Occasionally the brilliant yellow crystals of olivine have an outer coating of pale brown clay. Many of the crystals contain abundant small included grains of black iron ore. The forms present were identified by the following angles:

Angles of olivine from Minidoka.

Letter.	Miller.	Reflection.	Measured.		Calculated.	
			ϕ	ρ	ϕ	ρ
			° ′	° ′	° ′	° ′
b	010	Good......	0 00	90 00	0 00	90 00
m	110	Very good..	65 11	90 00	65 01	90 00
s	120	Good......	47 19	90 00	47 01	90 00
K	021	...do.......	0 00	49 16	0 00	49 33
d	101	Very poor..	90 00	50 48	90 00	51 32

QUARTZ.

Quartz in the form of angular dirty white or brownish sand occurs abundantly in the sands which have not been too far concentrated, this being the most abundant of the lighter constiuents eliminated by panning. This mineral also occurs frequently in concentrates of the heavy materials as small brilliant transparent colorless crystals formed by the combination of the plus and minus rhombohedrons without prismatic planes, as shown in figure 20. Many of these crystals resemble octahedral crystals of diamond where the hexagonal form is not easily distinguishable. Just why they should persist in the heavy concentrate rather than be eliminated by panning is not clear.

HORNBLENDE.

Although also a lighter constituent which is usually eliminated in concentrating, hornblende is occasionally present in the heavy concentrates. The mineral is usually in imperfect pale green prismatic forms which have an opaque weathered and frayed appearance. Fresher greenish-black cleavages of hornblende were noted in some samples, especially in Snake River sands from Wapi and Minidoka.

CORUNDUM.

Corundum is a mineral which has probably been removed from the sands by screening, as it ordinarily occurs in crystals much larger than the average grain of the sands and owing to its hardness and tenacity it is seldom reduced to small size by wear. This mineral was noted only as one or two crystals having the form of rounded hexagonal tablets in the sand from Rosa, Bingham County. Corundum is known to be common in many gold-bearing gravel deposits in the region around Pierce City and near Resort, in Idaho County. A placer mine near Meadows, in Washington County, has also yielded numerous crystals of corundum, some of gem quality. Specimens of corundum from Resort which are preserved in the United States National Museum are rough hexagonal crystals up to 1 inch in diameter having gray to blue and lavender colors. One crystal is tabular and brown in color with a bronzy metalloidal sheen.

CHALCOPYRITE.

Chalcopyrite was found as angular grains in a sand from Wapi on the Snake River. The broken fragments are without definite form and they all have a thin translucent enamel-like coating of some dull green material which resembles a colloidal iron silicate rather than an oxy-compound of copper. Broken irregular grains of chalcopyrite occur also in the radioactive samarskite concentrates from Idaho City.

OBSIDIAN.

While not a mineral, volcanic glass deserves mention as one of constant though not abundant constituents of the lighter sands from Snake River localities. It occurs as thin chips of a smoky gray to black color which have sharp edges and show traces of conchoidal fracture. The chips are not at all water-worn.

GOLD.

Gold in grains, flakes, and nuggets occurs frequently in the sands, and in many of those which contained no visible gold it was probably originally present having been removed by amalgamation. Flat

flakes of gold are of frequent occurrence in sands from Rosa, Bingham County, and less abundantly so in other Snake River sands from Wapi and Minidoka. Small rounded grains of a deep yellow color were noted in the nonmagnetic residue of a sand from Bear Creek, in Camas County. An "oversize" sample of coarse material from Centerville, consisting of pebbles of garnet, granular magnetite, irregular ilmenite, and several radioactive uranium minerals contained several slightly worn rusty quartz pebbles containing abundant pale-colored gold.

CYANITE.

While not properly a mineral of the heavy sands, cyanite was seen as grayish-blue blades in a rusty granular quartz matrix in one pebble from an unscreened sand from Snake River at Minidoka.

EPIDOTE.

Epidote may occur sparingly in some of the sands examined, being similar in appearance to augite and olivine, from which it could not be distinguished by its appearance alone. Pebbles of pale-green epidote in massive granular form were noted in the coarser portion of sand from Rosa, Bingham County, associated with pebbles of similarly fine-grained brown garnet, both evidently being fragments of a metamorphic hornfels.

CINNABAR.

Cinnabar occurs sparingly in a sand from Pierce City, which consists largely of ilmenite in brilliant black grains and also contains rutile, monazite, and zircon. The cinnabar is deep red in color with a grayish metallic cast. The majority of the grains are rounded pebbles of fine granular, massive cinnabar, but many of them are more or less transparent fragments of single cinnabar crystals and a few are crystals bounded by imperfect faces which could not be identified. It seems probable that much of the cinnabar of the original gravel was in larger masses which were eliminated by screening.

The United States National Museum collections contain pebbles of impure massive cinnabar up to 1 inch in diameter from a placer near Resort. Small rounded grains of cinnabar were noted in small number in the polycrase-bearing sand from Centerville.

LIST OF LOCALITIES AND COMPOSITIONS OF HEAVY SANDS EXAMINED.

The following list gives the locality, average size of grain, and chief minerals of the 52 sands from Idaho localities which were examined during the course of the present work. Each sand is as-

signed a new serial number, and the original number accompanying the sand is given. It is to be remembered that none of these are natural sands, all having been greatly concentrated by gravity processes or separated magnetically before coming to the museum. In many instances the samples are merely fractional products of several successive concentrating and purifying processes. The arrangement is by localities, the counties being listed alphabetically.

ADA COUNTY.

1. Snake River, near Boise. Original number P 114. Abundant quartz; rare obsidian, biotite, pyrope, augite, olivine, chalcedony, and hornblende. Probably tailings from a concentrating table. Average grain diameter 0.5 mm.
2. Same locality. Original number P 114. Abundant quartz; common augite and olivine; rare biotite and obsidian. Evidently also tailings. Average grain diameter 0.75 mm.
3. Same locality. Original number P 114. Abundant quartz and ilmenite; rare pyrope, almandite, biotite, magnetite, olivine, augite, and obsidian. Average grain diameter 0.5 mm.

BINGHAM COUNTY.

4. Snake River, at Rosa. "Auriferous sand." Cat. No. 53,625 U. S. N. M. Abundant ilmenite, magnetite, pyrope; occasional augite, almandite, and quartz; rare zircon, gold, olivine, corundum. Average grain diameter 0.1 mm.

BOISE COUNTY.

5. Centerville. "Monazite sand." No number. Abundant monazite, ilmenite, quartz, and zircon; occasional almandite. Grain diameter 0.3–0.5 mm.
6. Grimes Creek, Centerville. Original number P 249. Abundant quartz; common monazite, biotite, ilmenite; rare almandite and zircon. Grain size, average, 0.5 mm.
7. Centerville. "Monazite separated by Lovett separator." Cat. No. 90,480 U. S. N. M. Abundant monazite, zircon, ilmenite; occasional magnetite and quartz. Average grain diameter 0.50 to 0.75 mm.
8. West side of Grimes Creek, ¼ mile north of Centerville. Original number P 657*a*. Abundant quartz, kaolinized feldspar; rare muscovite, almandite, ilmenite, biotite, hornblende, and epidote. Average grain diameter 1 mm. Probably tailings.
9. Centerville. Original number P 771 "oversize." Common polycrase, ilmenite, samarskite; rare gold, uraninite (?), tapiolite (?), microlite (?), pyrochlore (?), monazite, hematite, magnetite. Average grain size 5 mm.
10. Oaks Placer Mine, Centerville. Original mark "P 670, ilmenite, 2.3 amperes." A magnetic concentrate. Abundant biotite; common monazite and zircon; rare epidote, quartz, limonite pseudomorphs after pyrite, and almandite. Grain size averages 1 mm.
11. Centerville. Originally marked "monazite 5 amperes." Abundant monazite, with rare zircon, muscovite, biotite, and feldspar. Grain size 0.50 to 0.75 mm.
12. Centerville. Original No. P 670. Marked "zircon, under tails, 20.2." Abundant zircon; rare quartz, garnet, monazite. Grain size varying from 0.10 to 2 mm.
13. Idaho City dredge, Idaho City. Original No. P 654. Mainly monazite with common ilmenite and zircon. Grain size 0.10 mm.

14. Same locality. P 654. Abundant monazite; common zircon; rare muscovite, polycrase (?), samarskite (?). Average grain size 0.50 mm.
15. Same locality. P 654. Marked "magnetite." Chiefly magnetite, with rare almandite, monazite, zircon, and ilmenite. Average grain size 0.10 mm.
16. Same locality. P 654. Marked "garnet." Almost wholly almandite; rare columbite, ilmenite, and samarskite. Grain size averages 2 mm.
17. Same locality. P 654. Marked "chromite." Abundant ilmenite; common almandite; rare chromite (?), columbite, polycrase, zircon. Grain size variable up to 2 mm.
18. Same locality. P 654. Marked "garnet." Abundant almandite, columbite, samarskite; rare limonite, zircon, monazite, polycrase. Maximum grain diameter 3 mm.
19. Same locality. P 654. Marked "monazite, through 80 on 100 mesh, 2.5 amperes." Abundant monazite; rare biotite, zircon, ilmenite, hornblende, titanite. Grain size, average, 0.10 mm.
20. Same locality. P 654. Marked "monazite, special, through 60 on 80 mesh, 3.50 and 3.75 amperes." Abundant monazite; rare zircon, muscovite, biotite, and ilmenite. Grain size 0.25 mm.
21. Same locality. P 654. Marked "olivine." Abundant samarskite, columbite; rare yttrotantalite (?), fergusonite (?), polycrase, monazite, cinnabar, chalcopyrite, zircon. Grain size, average, 2 mm.
22. Same locality. P 654. Marked "monazite, special, through 60 on 80 mesh, 4.00, 4.25, 4.50, 4.75, and 5.00 amperes." Abundant zircon and monazite; occasional ilmenite and muscovite. Grain size, average, 0.25 mm.
23. Same locality. P 654. Marked "monazite, special, through 60 on 80 mesh, 2 amperes." Abundant monazite, ilmenite, samarskite, zircon; occasional muscovite and biotite. Grain size, average, 0.25 mm.
24. Same locality. P 654. Marked "monazite, special, through 80 on 100 mesh, 4.50, 4.75, and 5.00 amperes." Abundant zircon, monazite, and quartz; common muscovite. Grain size, average, 0.2 mm.
25. Same locality. P 654. Marked "monazite, through 80 on 100 mesh, 3.75 amperes." Abundant monazite; occasional zircon, quartz, and muscovite. Grain size, average, 0.10 mm.
26. Same locality. P 654. Marked "monazite, through 80 on 100 mesh, 4.00 and 4.25 amperes." Abundant monazite; occasional zircon; rare quartz, muscovite, and ilmenite. Grain size, average, 0.10 mm.
27. Same locality. P 654. Marked "monazite, through 60 on 80 mesh; 3.25 amperes." Abundant monazite; common zircon; rare muscovite, biotite, chlorite, samarskite.
28. Centerville. Cat. No. 90,480 U. S. N. M. Abundant monazite, ilmenite; occasional zircon and magnetite. Average grain size 0.75 mm.

CAMAS COUNTY.

29. Bear Creek. Abundant magnetite, quartz; common almandite, limonite pseudomorphs after pyrite; rare gold, allanite, titanite, and zircon. Average grain size 1 mm.

CLEARWATER COUNTY.

30. Cow Creek, Pierce district. Original number P 280. Abundant ilmenite, pyrope; common quartz, monazite, and titanite; rare augite and zircon. Average grain size 1 mm.

31. Cow Creek, Pierce district. Original No. P 280*a*. Abundant ilmenite, monazite, and pyrope; occasional quartz; rare titanite. Grain size varying from 0.20 to 2 mm.
32. Pierce City. Original No. P 292. Predominant ilmenite; common monazite; rare gold, zircon, cinnabar, rutile. Grain size, average, 1 mm., maximum, 3 mm.
33. Rich Hill Mining Co., Pierce City. Original No. P 292. Marked "cinnabar." Abundant ilmenite and quartz; rare magnetite, muscovite, zircon, monazite, and cinnabar. Average grain size 2 mm.
34. Rhodes Creek, Pierce City. Original No. P 293. Predominant ilmenite; rare monazite, titanite, pyrope, zircon. Grain size, average, 0.5 mm.
35. Pierce City. Marked "oversize." Abundant ilmenite, pyrope, and quartz; occasional magnetite. Grain size, average, 5 mm.

ELMORE COUNTY.

36. Big Rock placer claim, Wood Creek. Original No. P 273. Marked "zircon." Predominant zircon; abundant garnet (pyrope?), monazite, and ilmenite. Grain size, average, 0.25 mm.

IDAHO COUNTY.

37. Resort. Original No. P 641. Marked "4.5 amperes." Predominant monazite; common black hornblende; rare ilmenite, biotite. Average grain size, 1.20 mm.
38. Salmon River. Original No. P 235. Marked "zircon." Predominant zircon; common gold, garnet, ilmenite, augite; rare olivine, monazite. Grain size, average, 0.10 mm.
39. Baboon placer, Elk City. Original No. P 219. Marked "monazite." Abundant monazite, titanite; common samarskite (?), ilmenite; rare polycrase (?), biotite, muscovite. Grain size, variable, 0.25 to 3 mm.
40. Same locality. P 219. Marked "zircon." Predominant zircon; abundant monazite; occasional ilmenite; rare almandite, gold, cinnabar. Grain size, average, 0.10 mm.

MINIDOKA COUNTY.

41. Riverside placers, Snake River, 8 miles east of Wapi. Original No. P 275. Predominant ilmenite; rare gold, zircon, augite, almandite, pyrope, quartz, olivine. Average grain size, 0.10 mm.
42. Same locality. Original No P 275. Predominant ilmenite; occasional pyrope, quartz, almandite, augite, zircon. Grain size, average, 0.10 mm.
43. Same locality. Original No. P 275. Predominant quartz; abundant ilmenite; occasional pyrope, almandite, augite, obsidian. Average grain size, 0.20 mm.
44. Same locality. Original No. P 275. Crushed oversize. Predominant quartz; rare muscovite, obsidian, limonite, chlorite. Average grain size, 2 mm.
45. Minidoka. Original No. 839*a*. Marked "Snake River gravel." Abundant ilmenite and augite; common olivine, pyrope, quartz; rare allanite (?), zircon, and magnetite. Average grain size 0.25 mm., unscreened and variable.
46. Same locality. Original No. 839*c*. Abundant quartz; common augite; rare olivine, limonite, obsidian. Variable grain, sand averaging 0.25 mm., but numerous small pebbles averaging 3 mm.

47. Same locality. Original No. 839*c*. Abundant ilmenite; common quartz; augite and pyrope; rare gold, almandite, magnetite, allanite (?). Sand averaging 0.50 mm., pebbles of various rocks up to 1 cm. in diameter.
48. Same locality. Original No. 839*y*. Abundant quartz; frequent augite, allanite (?); rare olivine, ilmenite, pyroxene. Grain size, average, 0.20 mm.
49. Snake River, Wapi. Original No. P 275. Abundant augite, pyrope, ilmenite; common quartz; rare olivine, biotite, magnetite, almandite, limonite, allanite (?). Average grain diameter, 0.30 mm.

NEZ PERCE COUNTY.

50. Early Bird placer, on Clearwater River, near Lewiston. Original No. P 627. Abundant pyrope; common ilmenite, hornblende, almandite; rare augite, olivine. Average grain diameter, 0.50 mm.
51. French Creek. Original No. P 664. Abundant ilmenite; common quartz; rare zircon, magnetite, monazite, titanite (?). Average grain diameter, 0.50 mm.

ONEIDA COUNTY.

52. Fall Creek placer, Snake River. Original No. P 236. Abundant quartz; common augite, ilmenite; rare muscovite, biotite, gold, almandite, obsidian, magnetite, pyrope, olivine. Average grain diameter, 0.20 mm.

NORTH AMERICAN ICHNEUMON-FLIES OF THE GENERA CLISTOPYGA AND SCHIZOPYGA.[1]

By R. A. Cushman,

Of the Bureau of Entomology, United States Department of Agriculture.

In a recent paper under joint authorship of the present writer and S. A. Rohwer reviewing Hellen's revision of the Pimplinae[2] the authors revised their previous placing[3] of the genus *Schizopyga* Gravenhorse to the extent of admitting it to the subfamily Ichneumoninae, but expressing no opinion as to which of the tribes recognized by themselves it should be referred to. In their own revision of the tribes[2] (p. 392) they referred *Clistopyga* Gravenhorst to the tribe Ichneumonini.

Subsequent study of these two genera has convinced them[4] that both should be referred to the Polysphinctini. Since the tribal keys in the paper cited were written with the idea of excluding both genera from this tribe, neither will run there, though it was realized at the time that *Clistopyga* would undoubtedly cause trouble at this point. In order to make the two genera fall in the Polysphinctini in the classification of Cushman and Rohwer, it is necessary to revise couplets 5 and 8 of the "Key to tribes based on females"[5] (pp. 388–391) and couplets 2 and 12 of the "Key to tribes"[5] (pp. 391–392). The keys thus revised are given below.

KEY TO TRIBES BASED ON FEMALES.

1. Ovipositor with a dorsal notch a short distance back from apex; (internal parasites of Lepidopterous larvae), fig. 1 .... 2.
   Ovipositor without such a notch .... 3.

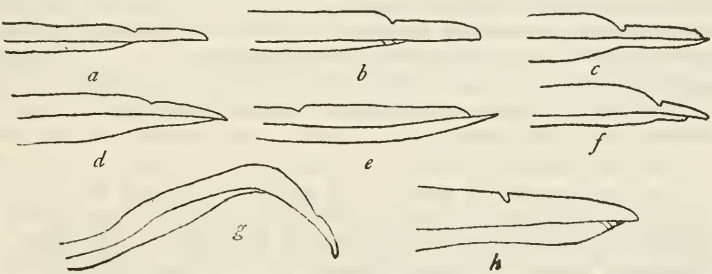


FIG. 1.—APICES OF OVIPOSITORS: *a*, GLYPTA SIMPLICIPES CRESSON; *b*, LAMPRONOTA AMERICANA CRESSON; *c*, ARENETRA NIGRITA WALSH; *d*, MENISCUS SCUTELLARIS CRESSON; *e*, CYLLOCERIA LUGUBRIS CRESSON; *f*, LAMPRONOTA FRIGIDA CRESSON; *g*, LISSONOTA VERBERANS GRAVENHORST; *h*, AMERSIBIA PRIONOXYSTI ROHWER.

[1] This paper is supplementary to the writer's revision of the tribe Polysphictini as published in Proc. U. S. Nat. Mus., vol. 58, 1920, pp. 13–38, and is the sixth in the series of papers by the present writer and S. A. Rohwer dealing with the North American species of the subfamily Ichneumoninae (Pimplinae of Ashmead).

[2] Cushman, R. A., and Rohwer, S. A., Ins. Mens., vol. 8, 1920, pp. 161–164.

[3] Cushman, R. A., and Rohwer, S. A., Proc. U. S. Nat. Mus., vol. 57, 1920, p. 396.

[4] The third person pronoun is used here with the approval of Mr. Rohwer.

[5] Proc. U. S. Nat. Mus., vol. 57.

2. Tergites without oblique furrows.................................Lissonotini.
   Tergites with oblique furrows extending from basal middle to near apical margin...Glyptini.
3. Tarsal claws pectinate; apex of ovipositor spear-head like; (parasites of Lepidopterous larvae), fig. 2.. 4.

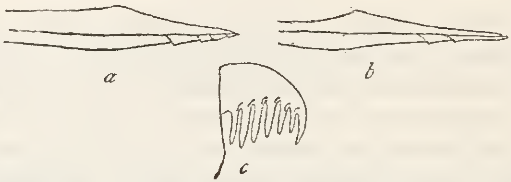


FIG. 2.—APICES OF OVIPOSITORS: *a*, TOXOPHORIDES ALBOMARGINATA (CRESSON); *b*, PHYTODIETUS BURGESSI CRESSON. HIND TARSAL CLAW: *c*, PHYTODIETUS BURGESSI CRESSON.

   Tarsal claws simple or with a large basal tooth or lobe, fig. 3............... 5.

FIG. 3.—HIND TARSAL CLAWS: *a*, ITOPLECTIS CONQUISITOR (SAY); *b*, ICHNEUMON IRRITATOR FABRICIUS.

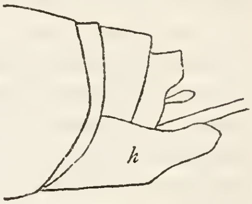


FIG. 4.—APEX OF FEMALE ABDOMEN OF TOXOPHOROIDES ALBOMARGINATA (CRESSON) (*h*=HYPOPYGIDIUM.)

4. Tergites 1–4 with oblique and apical transverse furrows and strongly sculptured; scutellum margined laterally; hypopygium heavily chitinized and extending to or beyond apex of abdomen, fig. 4.................................Lycorini.
   Tergites without furrows and polished; scutellum not margined; hypopygium neither especially heavily chitinized nor prominent.............Phytodietini.
5. Ovipositor short, never more than half as long as abdomen, compressed (rarely subcircular in cross-section), tapering from base to the acutely pointed apex and usually with a more or less distinct swelling below at or near the middle, straight or curved upward; clypeus convex, rounded or at most truncate at apex, rarely apically impressed and very rarely confluent with face; last tarsal joint, claws, and onychia usually large, all claws with basal tooth; face narrow and usually convergent below; mandibles narrow at apex, bidentate or edentate, in the former case usually with upper tooth longer than lower, in the latter case with a broad spoon-like inner flange; areolet only rarely defined (so far as known external parasites on spiders), fig. 5___________________Polysphinctini.

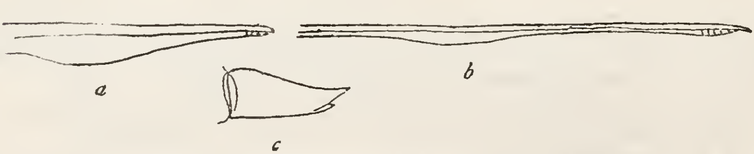


FIG. 5.—APICES OF OVIPOSITORS: *a*, POLYSPHINCTA TEXANA CRESSON; *b*, HYMENOEPIMECIS WILTII (CRESSON); MANDIBLE: *c*, HYMENOEPIMECIS WILTII (CRESSON).

Ovipositor either short or long, but never formed as above; clypeus most frequently impressed and emarginate medially, occasionally inflexed and truncate or rounded at apex; apical tarsal joints rarely swollen or with large claws and onychia; mandibles either broad and bidentate at apex with equal teeth or acute and edentate, in the latter case rarely with a small inner tooth.... 6.

6. Ovipositor never nearly as long as body, cylindrical, or nearly, occasionally depressed or decurved at apex; claws simple, without a basal lobe or tooth, occasionally (*Itoplectis*) with claws of front tarsi lobed or (*Apechthis*) all or front and middle claws lobed, in the last genus the ovipositor is decurved at apex; notauli either absent to obsolete or very deep and pit-like anteriorly, where they are set off by a sharp carina that runs back along the margin of the lateral lobe; areolet always present; nervellus always strongly reclivous with the discoidella at or near the upper end; clypeus broadly truncate or arcuate at apex, rarely with a distinct median notch-like emargination.............................. 7.

Ovipositor compressed, or if cylindrical it is very long and slender or upcurved; all claws either with or without basal lobes or teeth; notauli strong, rarely weak, or entirely wanting, but never defined as above........................ 8.

7. Dorsal margin of lance straight to apex; propodeal spiracle slit-like, the surrounding carina prominent, separated from anterior margin of propodeum by less than its length; notauli subparallel, terminating abruptly posteriorly; polished, with abdomen impunctate; species usually largely bright ferruginous or yellowish; (secondary parasites), fig. 6 ....Theroniini.

FIG. 6.—APEX OF OVIPOSITOR OF THERONIA FULVESCENS CRESSON.

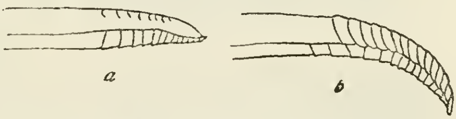


FIG. 7.—APICES OF OVIPOSITORS: *a*, ITOLPLECTIS CONQUISITOR (SAY); *b*, APECHTHIS PICTICORNIS (CRESSON).

Dorsal margin of lance either decurved near apex or it is flattened at apex; propodeal spiracle usually round to long oval, rarely slit-like, and usually separated from anterior margin of propodeum by at least its length; notauli, when strong, complete and convergent posteriorly; species usually black or blackish with abdomen distinctly punctured, seldom both pale and with abdomen polished impunctate; (internal parasites of Lepidopterous pupae), fig. 7........Ephialtini.

8. Hypopygium very large, vomeriform, acute at apex, very heavily chitinized; clypeus broadly truncate at apex, frequently sharply inflexed and with a more or less distinct median tooth; labrum exserted (parasites on wood-boring larvae), fig. 8 ....Acoenitini.

Hypopygium retracted from apex of abdomen .... 9.

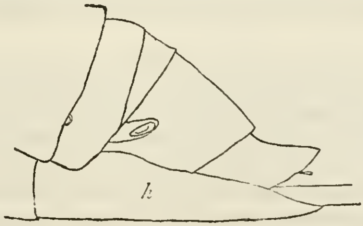


FIG. 8.—APEX OF ABDOMEN OF FEMALE OF COLEOCENTRUS OCCIDENTALIS CRESSON.

9. Occipital carina obsolete or interrupted dorsally; mesoscutum and scutellum transversely rugose throughout; apical tergite greatly lengthened; (external parasites on wood-boring larvae)..Rhyssini.
 Occipital carina complete; mesoscutum and scutellum not transversely rugose, at most the scutum is rugulose; apical tergite only rarely greatly lengthened...1 .
10. Abdomen inserted above, frequently far above, the hind coxae; first tergite narrow throughout; head transverse; occiput narrow, barely concave; temples short and strongly convexly sloping; eyes emarginate within; propodeum nearly straight and horizontal from base to insertion of abdomen; hind coxae, long, slender and nearly uniform in diameter, fig. 9 ....Labenini.

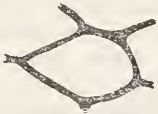


FIG. 9.—AREOLET OF LABENA GRALLATOR (SAY).

FIG. 10.—AREOLETS: *a*, TROMATOBIA RUFOVARIATA (CRESSON); *b*, ITOPLECTIS CONQUISITOR (SAY); *c*, EPIURUS ALBORICTA (CRESSON).

 Not agreeing entirely with above, fig. 10.................................. 11.
11. Abdomen sessile (not distinctly tapering from spiracles to base and with prominent anterior lateral angles), very rarely (*Perithous*) clavate and slightly compressed at apex; areolet usually defined; claws rarely without basal tooth; (external parasites on lepidopterous, coleopterous, and hymenopterous larvae and pupae, or in spider egg-sacs), fig. 11 ....Ichneumonini.

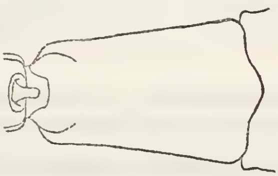


FIG. 11.—SESSILE FIRST TERGITE OF PERITHOUS PLEURALIS CRESSON.

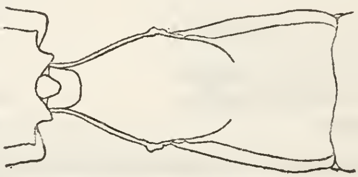


FIG. 12.—PETIOLATE FIRST TERGITE OF XORIDES YUKONENSIS (ROHWER).

 Abdomen petiolate (tapering from spiracles to base, and without prominent anterior lateral angles), clavate to subcylindrical and more or less compressed apically; areolet usually wanting; claws without basal tooth; temples broad; (external parasites on wood-boring larvae), fig. 12.................................. 12.
12. Mandibles edentate at apex, rarely with a small entodorsal tooth; legs slender, fig. 13...Xoridini.

FIG. 13.—MANDIBLE OF POEMENIA AMERICANA (CRESSON).

 Mandibles bidentate at apex, the teeth subequal in length; legs stout.
Odontomerini.

KEY TO TRIBES.

1. Abdomen inserted above, frequently far above, the hind coxae, first tergite narrow throughout; head transverse; occiput narrow, completely margined, barely concave; temples short and strongly convexly sloping; eyes emarginate within; propodeum nearly straight and horizontal from base to insertion of abdomen; hind coxae long, slender and nearly uniform in diameter; thoracic dorsum not at all transversely rugose...Labenini.
 Not agreeing entirely with above.. 2.

2. Mandibles edentate or with a much shorter entodorsal tooth; first tergite petiolate, spiracles before middle; areolet usually wanting; thorax depressed, mesopleura distinctly longer than high; head subquadrate; notauli complete or nearly so. Xoridini.

Mandibles usually bidentate apically with teeth subequal or upper tooth longer, rarely edentate in which case the inner margin is provided with a broad spoon-like flange-- 3.

3. Occipital carina wanting or interrupted medially; mesoscutum and scutellum transversely rugose throughout; abdomen inserted rather high on propodeum, occasionally far above insertion of hind coxae; first tergite with spiracles before middle and shorter than or subequal to second, which is parallel-sided. Rhyssini.

Occipital carina complete; mesocutum and scutellum not transversely rugose, at most the mesoscutum partially ruguluse.............................. 4.

4. Abdomen distinctly compressed in apical third or half, (deeper than broad). Acoenitini.

Abdomen not distinctly compressed.. 5.

5. Abdomen petiolate; head subcubical, swollen below antennae, not, or scarcely, narrowing behind eyes; eyes small and placed well forward, cephalo-candad length of posterior orbits longer than or subequal to that of eye; thorax and propodeum depressed, the latter very long dorsally, short posteriorly; legs, especially the femora, stout; areolet wanting..................Odontomerini.

Not entirely as above, though rarely agreeing with one or two characters..... 6.

6. Tergites, at least 2–4, with oblique furrows which converge anteriorly until they approximate in the dorsal middle.. 7.

Tergites without such furrows.. 8.

7. Tergites 1–5 in male, 1–4 in female, with apical transverse impressions which together with oblique impressions set off a median, transverse, sub-triangular area; malar furrow present; first tergite with dorsal carinae short; scutellum carinate laterally to apex; intercubitus nearly or quite twice as long as second abscissa of cubitus; nervellus strongly inclivous......................Lycorini.

First tergite without either oblique or transverse impressions, and with dorsal carinae extending beyond middle; other tergites usually without transverse apical furrows;[6] scutellum not carinate laterally; intercubitus not nearly twice as long as second abscissa of cubitus; nervellus reclivous, perpendicular, or slightly inclivous...Glyptini.

8. Tergites beyond first without either furrows, depressions, or elevated areas; dorsal carinae of first tergite defined at most only very briefly at base (in difficult species the spiracles of first tergite are very close to the base), mesoscutum anteriorly usually with a cuneiform pale spot on each side............... 9.

Tergites beyond first with more or less distinct elevated areas, depressions, or furrows or combinations of some or all of these factors; dorsal carinae of first tergite distinct and setting off a distinct basal concave area (in the very rare difficult species the spiracle of the first tergite is far from the base).............. 10.

9. Propodeum entirely without carinae; claws strongly curved, with few (about 6) very long, closely set teeth; entire body smooth, at most very minutely punctate...Phytodietini.

Propodeum usually with at least an apical transverse carina, rarely without carinae; claws long, weakly curved and if pectinate the teeth are smaller, more numerous, or sparsely set; at least the thorax dorsally and propodeum distinctly sculptured ....Lissonotini.

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[6] None of the North American Glyptini have the transverse furrows, but the South American genus *Zaglyptomorpha* Viereck has them on tergites 2–5. This genus, however, has none of the other characters of the Lycorini.

10. Propodeal spiracle slit-like, the surrounding carina prominent, separated from the anterior margin of the propodeum by less than its length; notauli subparallel, ending abruptly posteriorly; body smooth and shining, mostly bright ferruginous or yellow; propodeal carinae very strong and high..........**Theroniini.**
    Propodeal spiracle round or elongate the surrounding carinae not prominent, removed from the anterior margin of the propodeum by at least its length; notauli obsolete or converging posteriorly; usually sculptured and dark colored, occasionally ferruginous or polished, but rarely both; propodeal carinae obsolete or weak, at least not very high and strong...................... 11.
11. Notauli weak or absent; or if very strong and complete they are deep and pitlike anteriorly and set off by a sharp carina that runs back along the lateral margin of the mesoscutum;[7] head set very close to prescutum; mesopleural furrow straight or curved but not angulate opposite the punctiform fovea...**Ephialtini.**
    Notauli usually deep, at least anteriorly; the anterior margin of the mesoscutum distinctly trilobed; head, by reason of the longer pronotum, set off from the prescutum; mesopleural furrow angulate opposite punctiform fovea.... 12.
12. Notauli strongly impressed throughout, prescutum very prominent (if notauli are not strongly impressed, as in *Hymenoepimecis*, the prescutum is nevertheless very prominent and the other characters are especially well marked); temples flat or slightly convex, sloping to the strong occipital carina; face converging below and at least as long as wide at clypeus, the latter convex or slightly flattened, usually rounded at apex and with a reflexed margin, rarely (*Hymenoepimecis*) very weakly, broadly emarginate, never medially impressed or inflexed; mandibles narrow at apex, bidentate or edentate, in the former case usually with upper tooth longer than lower, in the latter case with a broad spoonlike inner flange; scutellum elevated and compressed from the sides; areolet very rarely defined ....**Polysphinctini.**
    Notauli rarely complete, weakly impressed posteriorly, prescutum not especially prominent; temples usually strongly rounded, very rarely flat, less sharply sloping; face usually wider than long; clypeus usually medially impressed and emarginate at apex, sometimes inflexed and truncate or very weakly emarginate; teeth of mandibles subequal in length; scutellum broad, convex, or flattened; areolet usually complete, occasionally wanting or incomplete..**Ichneumonini.**

The present writer's key to the genera of the Polysphinctini[8] will have to be modified for the inclusion of these two genera as follows:

KEY TO GENERA.

A. Clypeus not separated from face; mandibles edentate with a broad, spoonlike flange internally (fig. 14); ovipositor barely exserted.
Schizopyga Gravenhorst.

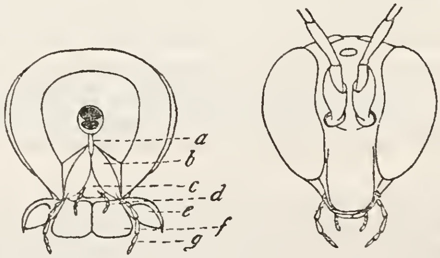

FIG. 14.—HEAD OF SCHIZOPYGA FRIGIDA CRESSON, REAR AND FRONT VIEW: *a*, GULAR SUBMENTAL-MENTAL REGION; *b*, CARDO AND STIPES OF MAXILLA; *c*, LABIUM; *d*, LABIAL PALPUS; *e*, MANDIBLE; *f*, LOBE OR MALA OF MAXILLA; *g*, MAXILLARY PALPUS.

[7] None of the Holarctic genera have the notauli strong, the genera in which they are strong being principally oriental.

[8] Cushman, R. A., Proc. U. S. Nat. Mus., vol. 58, 1920, pp. 16–17.

Clypeus separated from face: mandibles bidentate, without a flange internally; ovipositor distinctly exserted .... B.

B. Eyes parallel or nearly, face not convergent below and wider than long; clypeus truncate and flattened or impressed at apex; mandibles with teeth subequal; ovipositor curved upward, weakly compressed or subcylindrical; hypopygium reaching nearly or quite to apex of abdomen. Clistopyga Gravenhorst.

Eyes convergent below, face as long as wide at clypeal foveae; clypeus either rounded or truncate at apex, but never impressed; ovipositor straight, compressed; hypopygium retracted .... 1.

1. For remainder of key see Proceedings of the United States National Museum, vol. 58, 1920, pp. 16–17.

Genus SCHIZOPYGA Gravenhorst.

Schizopyga Gravenhorst, Ichn. Eur., vol. 3, 1829, p. 125. *Genotype*—*Schizopyga podagrica* Gravenhorst.

Very anomalous in its head characters, this genus agrees in most particulars with the more normal forms of the Polysphinctini. The form of the ovipositor, the tuberculate tergites, the deep and complete notauli, the swollen femora and apical tarsal joints, the dentate claws in the female, and the venation differ very little from those of the typical Polysphinctine.

The very peculiar head has the face long, flat, elevated above the level of the eye-margins, and completely fused with the clypeus, which is truncately rounded at apex. The mandibles are as described above, while the lobe, or mala, of maxilla is very large, almost quadrate, and when at rest lies beneath and against the mandibles meeting its fellow along the median line. The calcaria are very stout with a small apical spine-like process.

SCHIZOPYGA FRIGIDA Cresson.

Schizopyga frigida Cresson, Trans. Amer. Ent. Soc., vol. 3, 1870, p. 159. *Type.*—Cat. No. 1468, Acad. Nat. Sci. Phila.

Discussion based on a female homotype (Rohwer) from Mount Washington, New Hampshire, and another female from Ames, Iowa. The Mount Washington specimen has the hind tibiae and tarsi more extensively black than in the Iowa specimen and the coxae are piceous. Cresson's type is from Hudson Bay Territory.

Genus CLISTOPYGA Gravenhorst.

Clistopyga Gravenhorst, Ichn. Europ., vol. 3, 1829, p. 132. *Genotype.*—*Ichneumon incitator* Fabricius.

Readily distinguished from the other genera of the tribe by the parallel and practically nonemarginate eyes, the short hind tibiae, which never exceed the femora very greatly in length, and, in the female, the large hypopygium and upcurved ovipositor.

Ashmead's translation of Foerster's character for separating this genus from *Polysphincta*, etc., conveys exactly the opposite idea from that intended by Foerster. The ventral borders of the terminal

tergites are farther separated than normal instead of inclosing the "terminal urites." However, Foerster's method of expressing the character is awkward. A specimen of the genotype, *Clistopyga incitator* (Fabricius), determined by Roman, has the hypopygium prominent but not extending far beyond the apex of the abdomen and not inclosed by the tergites; the claws are not pectinate, as stated by Ashmead, but are strongly toothed basally; the ovipositor is upcurved. The females of all the other species studied agree in all of these characters. In some species the male has the lower cheek deeply impressed and highly polished, the impression flanked on the outer side by a high, sharp ridge. This last has been referred to by Schmiedeknecht[9] and by Morley[10] as a generic character.

Biological records concerning the members of this genus are conflicting. Among the specimens examined are only two such records. The types of one of the new species described below are said to have been reared from a "spider nest," and a male of another new species labeled "Hopkins U. S. No. 13334*h*" is said to have been found as an adult in the burrow of *Calopus angustus* LeConte in *Pinus murrayana* at Yosemite National Park. *Clistopyga incitator* (Fabricius) of Europe is said by Brischke to have been reared from *Retinia resinana*, while Morley quotes records of its having been reared from "beech infested with *Anobii* and *Ptilinus pectinicornis*" and from galls of *Cynips kollari*. The "spider nest" mentioned above accompanied the specimens, but unfortunately whether it was an egg sac or the retreat on an adult spider could not be determined because of its condition. It seems likely that the records associating species of the genus with other than spiders have resulted from the place of abode of a spider host.

The seven North American species are very readily distinguished by the characters used in the following table. So few males are available for study that this table is based only on females, with male characters given where specimens of that sex are at hand. The first character used, the comparative length of hind tarsi and tibiae, can not, as worded, be applied to males, the orbital character being better used for that sex.

TABLE TO SPECIES.

1. Posterior tarsi nearly twice as long as their tibiae, the latter distinctly shorter than their femora; yellow orbital ring strong and extending uninterrupted to beyond top of eye ---------- 2
   Posterior tarsi not nearly twice as long as their tibiae, the latter subequal to or slightly longer than their femora; yellow orbital ring incomplete or absent ---------- 3
2. Hind and middle tibiae blackish with whitish annulus, first four joints of their tarsi blackish with white basal ring; propodeum with a median longitudinal furrow ---------- **recurva** (Say).

[9] Opusc. Ichn., vol. 3, p. 1174.

[10] Brit. Ichn., vol. 3, p. 138.

Hind tibiae and tarsi practically concolorous with their femora, the tibiae obsoletely annulated, the tarsi pale and not annulated; propodeum without longitudinal furrow**pulchripicta** Ashmead.

3. Thorax more or less red below; orbital ring indicated at least by yellow marks at sides of face and above eyes 4

Thorax entirely black; face black without markings; orbital ring entirely or practically wanting, being sometimes represented by a very minute indistinct reddish spot at top of eye and in male at sides of face 6

4. First tergite elevated in middle, the carinae strong nearly to apex; mesopleural furrow crenulate above; mesoscutum black; ovipositor stout, uniformly curved**maculifrons**, new species.

First tergite flattened above, carinae obsolete beyond summit; mesopleural furrow not crenulate; mesoscutum more or less red; ovipositor slender, straight to beyond middle 5

5. Prescutum black; orbital ring represented by three yellow spots, two at top of eye and one just below antenna; propodeum polished, sparsely punctate**nigrifrons**, new species.

Prescutum red, the mesoscutum with a median black spot flanked on either side by a yellow spot; orbital ring complete from vertex to malar space, cheek also yellow; propodeum anteriorly transversely punctate-striate. **manni**, new species.

6. Propodeum with distinct median carinae; ovipositor sheath much less than twice as long as first tergite; hind tibia in female not longer than femur; cheek in male deeply impressed, the impression flanked on the outside by a strong carinate tubercule**canadensis** Provancher.

Propodeum without median carina or impression; ovipositor sheath very nearly twice as long as first tergite, the ovipositor very slender, strongly compressed and very attenuate at apex; hind tibia in female longer than femur; cheek of male normal**atrata**, new species.

CLISTOPYGA RECURVA (Say).

Anomalon recurvus SAY, Boston Journ. Nat. Hist., vol. 1, 1835, p. 243. (LeConte ed., vol. 2, p. 698). *Type.*—Lost.

Clistopyga annulipes CRESSON, Trans. Amer. Ent. Soc., vol. 3, 1870, p. 150. *Type.*—No. 1443, Acad. Nat. Sci. Phila.

Clistopyga recurva (Say), CUSHMAN and GAHAN, Proc. Ent. Soc. Wash., vol. 23, 1921, p. 157. Neotype in U. S. N. M.

Discussion based on notes on Cresson's type, a neotype designated by Cushman and Gahan, and other material.

This, the most abundant North American species of the genus exhibits in the most marked degree the peculiar characters of the genus. The eyes are very widely separated, inwardly parallel and barely emarginate; the orbital maculation very strong; the thorax fully twice as long as high, with the posterior margin of the mesopleurum extremely oblique, and the propodeum very long, gently sloping, and without carniae; the abdomen long and slender; the first tergite flattened above with the carinae obsolete beyond the summit; the hind tibiae distinctly shorter than their femora and barely half as long as their tarsi.

There is considerable variation in both size and color. The females are from 8 to 12 mm. long, with ovipositor from 1.75 to 2 mm. long. The yellow markings are fairly constant except on the face,

this varying from yellow with a narrow median stripe and the clypeal suture brownish to entirely brownish except the orbits and a small spot below each antenna. The thorax, except for the usual yellow markings, varies from entirely black with faint reddish reflections on the mesosternum to distinctly reddish both below and above, with the scutellum especially bright, and with a distinct whitish mark on each side of the middle of the mesoscutum. The tergites are frequently very narrowly edged with white though sometimes entirely black. The hind tibiae are usually very dark fuscous but occasionally pale fuscous, and the extent of dark color on the tarsal joints varies widely.

The only male that I have seen is 5.5 mm. long. It has the mesocutum and mesopleura and metapleura red, the face entirely yellow, the front and middle legs white except faint indications of tibial and tarsal annulations, the hind coxae stramineous, the trochanters and the femora outside (largely) white; the tibiae and tarsi colored as in female but the white somewhat more extensive. The cheeks are normal. The hind tibiae are about as long as the femora and first trochanter joint together and about equal in length to the first four tarsal joints. The abdomen is very slender and parallel sided with the first tergite twice as long as wide at apex and the others only about three-fourths as wide as long.

Say's type was from Indiana and Cresson's from Massachusetts. Other specimens are from Anglesea, New Jersey (F. Haimbach); Washington, District of Columbia (F. C. Pratt); Falls Church, Virginia (N. Banks); Ocean View, Virginia (A. N. Caudell) (*neotype*); Raleigh, North Carolina; Mississippi; Texas (Belfrage).

CLISTOPYGA PULCHRIPICTA Ashmead.

Clistopyga pulchripicta ASHMEAD, Proc. U. S. Nat. Mus., vol. 12, 1890, p. 448, female. *Type.*—Cat. No. 2114, U. S. N. M.

Discussion based on type.

That portion of Ashmead's description referring to the oblique grooves is misleading. The grooves are not analogous to those of *Glypta* but are far down on the sides and are not especially conspicuous.

This species is very closely allied to if not synonymous with *recurva* (Say), most of the distinguishing characters observed being incorporated in the table to species. In addition the nervellus is broken somewhat higher up and the thorax is largely red. All of these characters are variable in *recurva*.

The only known specimen is the type, which is from Texas.

CLISTOPYGA MACULIFRONS, new species.

This species is very distinct from either of the previously described North American species (*Clistopyga recurva* (Say), *Clisto-*

pyga pulchripicta Ashmead, and *Clistopyga canadensis* Provancher), but structurally is more closely allied to *canadensis* Provancher than to either of the others or the following two new species.

Female.—Length 6.5 mm., antennae (broken), ovipositor 1.6 mm. Head with temples slightly convex, polished, impunctate behind the eyes, frons sparsely, face densely punctate; face slightly wider than long; malar space nearly as long as basal width of mandible; ocelli arranged in a nearly equilateral triangle, the postocellar and ocellocular lines equal and about one and one-half times greatest diameter of a lateral ocellus; thorax not especially long, arched above, weakly and sparsely punctate laterally and ventrally, somewhat more densely and strongly so above, especially the propodeum, on which transverse aciculation and punctation are mingled, and which has two very short carinae above, subtending a median groove; propodeum strongly arched; mesopleural furrow crenulate above; hind tibia very slightly longer than the femur and nearly three-fourths as long as the tarsus, the basal joint of which is equal to the second and third together; nervellus broken about one-third above the brachiella; abdomen finely, deeply, densely punctate; first tergite with dorsal carinae extending nearly to apex, the area between polished, laterally with a rather distinct oblique impression apically and a low nearly circular elevation; tergites 2–5 with basal oblique and apical transverse impressions setting off strong elevations; tergites 2–6 successively, gradually shorter, 7 and 8 retracted, 8 with an upturned apical rim; ovipositor rather stout and uniformly upcurved.

Piceous black with mesosternum and pleura and metapleura testaceous; tegulae, pronotum narrowly above, clypeus, a stripe below each antenna, inner orbit below, a spot on upper orbit, scape, and basal flagellar joint below, yellowish white; legs generally testaceous with front coxae, front and middle trochanters, a more or less distinct annulus on each tibia and basal portion of first three joints of all tarsi whitish; other portions of tibiae and tarsi more or less infuscated the color on the hind legs being nearly black; wings hyaline, veins fuscous, whitish at base.

Type locality.—Texas.

Type.—Cat. No. 20058, U.S.N.M.

CLISTOPYGA NIGRIFRONS, new species.

Differs from *maculifrons* Cushman, principally as follows:

Female.—Length 7.0 mm.; antennae (broken); ovipositor 1.4 mm. Head less strongly punctate, the front entirely impunctate; malar space fully as long as basal width of mandible; postocellar line about a half longer than ocellocular line, the latter about equal to greatest diameter of a lateral ocellus; thorax polished and practically im-

punctate below, very sparsely, weakly so above; mesopleural furrow not crenulate; propodeum barely arched, polished behind and medially at base, without carinae but with a weak median furrow; punctation, impressions, and elevations of tergites weak, the first tergite practically noncarinate, the carinate flattened beyond the anterior angles; ovipositor shorter, more slender and tapering, and less strongly curved.

Face black except for minute reddish spot below each antenna and an orbital spot opposite these; upper orbits narrowly yellow from inner eye emargination to top of eye with a brief interruption opposite the ocellus; thorax black with mesopleura, except large spot below posterior wing, mesosternum, metapleura, scutellum, parapsides, and anterior lateral angles of prescutum, testaceous; scutellum and postscutellum tipped with yellowish white; white dorsal margin of pronotum extending beyond notauli; legs similarly colored except that apical annulus of tibia is prolonged below to base and the tarsi are not distinctly annulated.

A single female paratype differs from the type only in size, having the following measurements: length, 5.5 mm.; antennae, 4 mm.; ovipositor, 1.25 mm.

Type locality.—Mountain View, California,

Host.—"On spider nest."

Type.—Cat. No. 20059, U.S.N.M.

Described from the above two specimens reared from the host in July, 1898 (Ehrhorn), under No. 8524o^1.

CLISTOPYGA MANNI, new species.

Closely related to *nigrifrons* Cushman, but larger, more slender, and with more slender legs. Compared with the above description of *maculifrons* Cushman differs as follows:

Female.—Length 8 mm., antennae 6 mm., ovipositor 1.6 mm. Face weakly punctate, frons polished, impunctate; malar space as long as basal width of mandible; postocellar line distinctly longer than ocellocular line, the latter subequal to greatest diameter of lateral ocellus; thorax highly polished, only very obscurely punctate; propodeum weakly arched, with a median groove but without carinae; mesopleural furrow not crenulate; nervellus broken at lower fourth; abdomen shining, the punctation sparser and less deep; first tergite with dorsal carinae obsolete beyond summit; apical impression and lateral elevation less distinct; ovipositor slender, straight to beyond middle.

Head black with distinct orbital markings extending from top of eye to malar space; cheeks also white; a small spot on face below each antenna; clypeus, mandible at base, palpi, scape and pedicel below whitish; thorax mostly red, with pronotum below, propleura,

a discal spot on mesoscutum, spot below hind wing, metasternum, propodeum dorsally, and sutures black to piceous; dorsal margin of pronotum, spot below front wing, tegulae, small spot on each side of middle of mesoscutum, apices of scutellum and postscutellum, whitish; front and middle legs white in front, femora and tibiae stramineous behind, middle tibia with dark mark outwardly, hind coxa testaceous, white at apex, trochanter white, basal joint piceous at base, femur pale testaceous, tibia white with fuscous subbasal spot and apical annulus, tarsi white with joints fuscous at apex; wings yellowish; abdomen black.

Type locality.—Pacific Grove, California.

Type.—Cat. No. 24164, U.S.N.M.

One female captured by W. M. Mann.

CLISTOPYGA CANADENSIS Provancher.

Clistopyga canadensis PROVANCHER, Nat. Can., vol. 12, 1880, p. 45. *Type.*—Public Museum, Quebec. Female bearing yellow label 396.

Discussion based on notes by S. A. Rohwer on type and female paratype, and female in collection of Mr. Nathan Banks, together with one female and two males in United States National Museum collection.

Very distinct from any of the foregoing species by reason of its almost entire lack of maculation. Face shining with distinct, separate punctures medially, frons and orbits impunctate; ocelli small, postocellar line slightly longer than ocell-ocular line; scutellum and postscutellum shining, practically impunctate; wings dusky, nervellus broken slightly below middle; tergites with distinct, rather close punctures, second slightly longer than third; ovipositor rather weakly upcurved.

The female from the collection of Mr. Banks agrees with Provancher's description and also with the above. It is 8.5 mm. long. Those portions noted by Provancher as being white (that is, palpi, front trochanters, and tegulae) are somewhat darker, and there is no trace of the white annulus on the front tibia. The orbital maculation is represented by very minute reddish spots at the top of the eyes. The thorax is strongly compressed. The first tergite is slightly elevated above with the carinae strong to summit. Two males in the National Museum collection agree very well with the female. The sculpture is slightly stronger. The lower cheeks are impressed and carinate. In one of the males the orbital maculation is exactly as in the female; but in the other it is yellowish and more extensive, being also represented by a short, narrow line at the side of the face.

The type is from Cap Rouge, Quebec; the Banks specimen from Middlesex Falls, Massachusetts; the National Museum female from Nerepis, New Brunswick (A. G. Leavitt), and the two males from Colorado and Oswego, New York.

CLISTOPYGA ATRATA, new species.

In color and structure very similar to *canadensis* Provancher, but distinctly more slender.

Female.—Length, 7 mm.; antennae, 4 mm.; ovipositor, 1.75 mm. Slender; head in front view transverse, polished, except face, which has distinct well separated punctures; face convex with a median rounded elevation; clypeus medially triangularly impressed nearly to base; malar space hardly as long as basal width of mandible; diameter of lateral ocellus equal to postocellar line and longer than ocell-ocular line; thorax polished, mesoscutum and scutellum slightly roughened; metapleurum sparsely and finely punctate; propodeum without median carinae, sparsely punctate laterally, transversely arcuately striate behind; nervulus postfurcal, nearly perpendicular; nervellus broken far below middle, perpendicular; hind tibia longer than femur; abdomen nearly twice as long as head and thorax, finely, densely punctate, the tergites with distinct elevations and impressions, first tergite slightly elevated with carinae strong to summit of elevation; ovipositor slender, distinctly compressed, and straight to near apex, sheath nearly twice as long as first tergite.

Black; clypeus piceous; basal flagellar joints pale beneath; palpi, humeral angle of pronotum, and tegulae whitish; wings hyaline, very slightly brownish stained; legs testaceous, front legs, especially coxae and trochanters almost stramineous, hind tibia fuscous with a white annulus, reddish below at apex, hind tarsus fuscous with the first three joints more or less white at base, the same pattern repeated in less contrasting colors on middle tibia and tarsus.

Male.—Like female but thorax and abdomen more strongly sculptured; upper orbits with a small brownish mark; front coxae and trochanters white; cheeks normal.

Type locality.—Berkley, California.

Allotype locality.—Yosemite National Park, California.

Type.—Cat. No. 24165, U.S.N.M.

One female taken in September, 1914, by E. P. Van Duzee and one male taken August 10, 1917, by J. E. Patterson and recorded under Hopkins U. S. No. 13334*h*, which shows it to have been taken from the gallery of *Calopus angustus* Le Conte in *Pinus murrayana*.

SPECIES WRONGLY INCLUDED IN CLISTOPYGA.

(*Clistopyga nigrocephala* Davis)=*Polysphincta* (*Zatypota*) *nigrocephala* (Davis).

(*Clistopyga pleuralis* Ashmead)=*Asphragis pleuralis* (Ashmead).

(*Clistopyga truncata* Provancher)=*Glypta truncata* (Provancher).

(*Clistopyga zonata* Davis)=*Tromatobia zonata* (Davis).

NORTH AMERICAN PARASITIC COPEPODS BELONGING TO THE FAMILY DICHELESTHIIDAE.

By Charles Branch Wilson,
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INTRODUCTION.

This is the sixteenth[1] paper in the series dealing with the parasitic copepods in the collection of the United States National Museum, and comprises the family Dichelesthiidae.

The genera belonging to this family are closely related to the Caligidae and Lernaeidae and are included with them in the group known as the Caligoida. They are gill parasites and when fully developed the females probably remain attached to the same spot on the gills of their host. In this sense they may be properly called fixed parasites, but they never burrow into the tissues of the host after the manner of the Lernaeidae, and yet one of the genera, *Caetrodes*, furnishes a very respectable compromise in this direction. While it does not itself burrow into the gill filament of its host, it does in some way so irritate the gill epithelium that the latter grows up into a flap or fold, entirely surrounding the body of the copepod and holding it securely in place.

Also other genera, such as *Anthosoma*, *Eudactylina*, *Nemesis*, and *Dichelesthium*, produce enough irritation with their prehensile claws in the gill epithelium to cause it to grow up around the claws themselves, but so far as known it never surrounds any portion of the copepod's body, not even the anterior margin of the head. In consequence of thus remaining at least partially free there is no instance of any material change in the parasite's bodily form or structure sub-

[1] The fifteen preceding papers, all of which were published in the Proceedings of the United States National Museum, are: 1. The Argulidae, vol. 25, pp. 635–742, pls. 8–27. 2. Descriptions of Argulidae, vol. 27, pp. 627–655, 38 text figures. 3. The Caliginae, vol. 28, pp. 479–672, pls. 5–29. 4. The Trebinae and Euryphorinae, vol. 31, pp. 669–720, pls. 15–20. 5. Additional Notes on the Argulidae, vol. 32, pp. 411–424, pls. 29–32. 6. The Pandarinae and Cecropinae, vol. 33, pp. 323–490, pls. 17–43. 7. New Species of Caliginae, vol. 33, pp. 593–627, pls. 49–56. 8. Parasitic Copepods from Pacific Coast, vol. 35, pp. 431–481, pls. 66–83. 9. Development of Achtheres ambloplitis Kellicott, vol. 39, pp. 189–226, pls. 29–36. 10. The Ergasilidae, vol. 39, pp. 263–400, pls. 41–60. 11. Descriptions of New Genera and Species, vol. 39, pp. 625–634, pls. 65–68. 12. Descriptions of New Species, vol. 42, pp. 233–243, pls. 30–34. 13. The Lernaeopodidae, vol. 47, pp. 565–729, pls. 25–56. 14. The Lernaeidae, vol. 53, pp. 1–150, pls. 1–21. 15. The Sphyriidae, vol. 55, pp. 549–604, pls. 50–59.

sequent to attachment. The grotesque transformations so common in the Lernaeidae and Sphyriidae are entirely unknown here, and there are not the complicated differences in size and morphology between the two sexes. The males are smaller than the females but they never become pygmies, and the structure of the two sexes is so similar that it betrays specific as well as generic identity.

The material for the present paper has been derived chiefly from the collection of the United States National Museum, which included most of the genera. This material has been supplemented with specimens collected by the present author at Beaufort, North Carolina, in 1905, while working for the United States Bureau of Fisheries, which include six new species.

There are also three more of the drawings by J. H. Blake, placed at the author's disposal by the late Dr. Richard Rathbun. Specimens, descriptive notes, and pencil sketches of a new species of *Lernanthropus* from the Pacific coast came to the author many years ago from Dr. M. T. Thompson.

The same methods of dehydration and clearing have been used as in the Lernaeidae and Sphyriidae, and with excellent results. Much of the internal morphology has been determined from these cleared specimens, and they have been supplemented by serial sections of *Nemesis*, *Eudactylina*, *Dichelesthium*, and *Lernanthropus*.

As here constituted the family is made up of 20 genera, of which one, *Bassettithia*, is a new genus name to take the place of one already occupied, and 107 species, of which 9 are new to science.

The present author has been unable to examine any specimens belonging to the genera *Norion*, *Krøyeria*, *Congericola*, *Lamproglena*, *Donusa*, *Bassettithia*, *Pseudoclavella*, *Cybicola*, and *Ventriculina*. But it has seemed wise to include keys to the species of these genera, based necessarily upon their published descriptions.

HISTORICAL.

Abildgaard was the first to notice any of the species belonging to this family. In 1794 he described and figured [2] two new species, which he referred to the genus *Caligus* and named, respectively, *crassus* and *oblongus*. In 1816 Leach, probably without knowing of Abildgaard's description and figures, established a new genus and species upon some specimens from the gill cover of a shark captured on the coast of England, which he named *Anthosoma smithii*.[3] About the same time or a little later Risso published his "Histoire Naturelle des Crustaces des environs de Nice," in which he described (p. 162) a new species of the genus *Caligus*, which he called *Caligus imbricatus*. Leach afterwards had an opportunity of examining

[2] Skrivter af naturhistorie Selskabet, Kjøbenhavn, vol. 3, pp. 46–54, pl. 5, figs. 1–11.
[3] Suppl. Encyc. Brit., vol. 1, p. 406.

Risso's type specimens and found them the same as his own, yet Risso described them again in 1826 under the name *Otrophesia imbricata*,[4] and even quoted Leach as the authority for his new generic name. A careful examination of the three descriptions and their accompanying figures makes it evident that they were all dealing with the same species. But it is not a species of *Caligus*, and hence Leach's generic name is valid with the specific name given by Abildgaard, and the species becomes *Anthosoma crassum*. It was retained, however, in the genus *Caligus* by Lamark, who even made separate species of *imbricatus* and *smithii*. All other authors since Leach have adopted his genus, although there has been considerable division of opinion over the three specific names.

Similarly Abildgaard's second species, *oblongus*, was made the type of a new genus by Hermann in his "Memoire Apterologique" in 1804. Like Leach, he seems not to have known of Abildgaard's description and figures, for he named his new genus type *Dichelesthium sturionis*. This genus name was adopted by Oken, 1816, Desmarest, 1825, and Nordmann, 1832, but was changed to *Dichelestium* by Latreille, 1817, and all other subsequent authors except M. J. Rathbun, 1905, and Norman and T. Scott, 1906, who retained Hermann's original spelling. To none of them, however, except White, 1850, and the last two just mentioned, not even to those who claimed that Abildgaard's species and Hermann's were identical, did it occur that the species name given by the former must take precedence over that of the latter (see p. 86).

To these two original genera others have been added from time to time, as indicated in the key upon page 20. Of these Blainville added *Lernanthropus* in 1822, Nordmann contributed *Lamproglena* in 1832 and *Donusa* and *Norion* in 1864, P. J. van Beneden contributed *Ergasilina* in 1851, *Eudactylina* and *Krøyeria* in 1853, and *Congericola* in 1854. He was apparently unaware that this last genus was identical with Milne Edwards's *Cycnus*, since he makes no mention of the latter. But since the name *Cycnus* had been preoccupied (see p. 57) Beneden's name becomes valid.

The remaining genera have come at scattered intervals, most of them within the present century. The descriptions and figures have been uniformly good, so that now we have reliable data upon their general form and habits. But there has been much less information with reference to their internal morphology and their life history.

Heider in 1879 published a monograph entitled "Die Gattung Lernanthropus," in which he gave an excellent account of the internal anatomy, and included also the minute histology of the various tissues, but this is the only genus to be so treated, and in reference to

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[4] Hist. Nat., Paris, vol. 5, p. 136.

the life history Heider gave merely the oögenesis, with nothing on the larval development. Heider's remarkable description has served as a basis for the present paper, and with it have been compared the morphology of *Dichelesthium*, *Nemesis*, and *Eudactylina.*

ECOLOGY.

While the component genera and species of the present family are fixed parasites in the sense that they do not move about freely over their hosts like the Caligidae and Argulidae, they are not absolutely incapable of motion like the Lernaeidae. Consequently while there is a greater or less loss of the powers of locomotion there is no marked sexual dimorphism, the body frequently retains its segmentation and flexibility, and none of the appendages are lost or abnormally transformed.

Sexual dimorphism.—There is more or less disparity in size between the two sexes, but the general body structure remains the same, so that the male of any genus can be easily located through its resemblance to the female, and while the males are always smaller than the females they are never reduced so much as to become pygmies.

In the subfamily Anthosominae the genus *Lernanthropus* is the one in which the male is best known. Here the male is not only smaller than the female, but it lacks the dorsal plates which cover the body of the latter, so that the laminate legs project for their entire length in dorsal as well as in ventral view. The segments of the thorax are more completely fused than in the female and are seldom indicated by anything except the modified legs.

In the subfamily Eudactylinae the males of *Congericola*, *Nemesis*, and *Eudactylina* are known. They differ from the females in having a relatively shorter and narrower genital segment, and the segmentation in the *Nemesis* male is almost wholly obscured.

In the subfamily Pseudocycninae the males of *Pseudocycnus*, the only ones known, differ from the females in the fact that the long genital segment of the latter is replaced by a very short, almost spherical segment, in front of which the fourth legs stand out rigidly on either side. The cephalothorax is relatively the largest region in the body, while the abdomen terminates in two large flaring anal laminae.

In the subfamily Dichelesthiinae the males of *Hatschekia* and *Dichelesthium* are almost perfect counterparts of the females, half a size smaller. None of the males in any of these subfamilies is found attached to the female after the manner of the pygmy males of the Lernaeopodidae and Sphyriidae. But they are all attached independently to the host in the same manner as the females.

Locomotion.—Both sexes are free swimmers during development, but after attachment to their host it is probable that they do not move about. The swollen and lacerated condition of the host's skin at the spot where the female parasite's claws penetrate it indicates that the attachment is a permanent one and not temporary. The structure of the second antennae, which serve as attachment organs in most of the genera, also indicates that they are intended for permanent attachment. And at least in *Anthosoma* and *Dichelesthium*, and in both sexes of the latter, the skin of the host grows up around the buried claws and completely envelops them. Neither sex of *Hatschekia*, *Nemesis*, or *Eudactylina* is fastened as securely as this, and they could easily loosen their hold upon the gill filament and move about from one place to another after the manner of *Ergasilus*, and it is possible that the males may go farther than this, for when removed from the gills and placed in water the male of *Nemesis* is able to move itself about vigorously by means of its swimming legs, and can even swim in a bungling fashion, but the body of the female is apparently too heavy and she quickly sinks to the bottom.

Prehension.—The chief organs of prehension are the second antennae and maxillipeds. The former are large and powerful in all the genera and are armed sometimes with stout claws, as in *Lernanthropus*, *Norion*, and *Hatschekia*, and sometimes with strong chelae, as in *Krøyeria*, *Dichelesthium*, and *Pseudoclavella.* In *Anthosoma* the second antennae are also elongated and form a pair of arms something like the maxillae of the Lernaeopods. In *Nemesis* and *Eudactylina* the second antennae are weaker, while the maxillipeds are greatly enlarged and become chelate, so that they usurp most of the functions of prehension.

When the second antennae terminate in claws the two appendages are opposed to each other like the arms of a pair of pincers, and the tips of the claws are usually thrust past each other so that they overlap for quite a distance, and in this way a very firm hold is obtained. In fact, the skin and flesh of the host have to be cut away before the parasite can be removed. On the other hand, if each antenna terminates in a chela, they are attached separately and usually some distance apart. The chela is supposed to give a somewhat stronger and more permanent form of attachment, but the interlocking of the claws just mentioned makes them fully as powerful as the chelae.

Hosts.—This family of parasites is confined exclusively to salt-water fish, and practically all of them to the fish's gills. The genera *Eudactylina*, *Krøyeria*, *Nemesis*, and *Ergasilina* infest sharks and rays of various species; *Anthosoma* is found on sharks and the sunfish; *Dichelesthium* has thus far been found only upon the sturgeon;

Lernanthropus and *Hatschekia* are cosmopolitan, using a great variety of fish from every ocean and nearly every latitude; *Congericola* is found on the Labridae, or wrasse fishes, chiefly in the Mediterranean; most of the other genera are made up of single species widely scattered.

Being found chiefly upon nonedible fishes, the species of this family have but little economic importance, and in addition they are of such small size and occur in such limited numbers that their importance is still further restricted. In most families of parasitic copepods the number of specimens upon a single host may be increased under favorable conditions until it becomes a menace to the life of the fish. Nothing of the sort has ever been reported in connection with the present family.

Food.—The presence of the great majority of the species upon the gills of their hosts and the color of the contents of the digestive tube when freshly examined leave no doubt that these parasites eat the blood of their host. The walls of the stomach also have the same structure as those of other blood eaters. That the amount consumed by a single parasite is small may be inferred from the fact that it is content to remain upon the gills, in company with other kinds of parasites, instead of boring into the flesh to get at some large blood vessel.

MORPHOLOGY.

General body form.—In general the body of a dichelesthiid is elongate and tapers gradually from the head to the abdomen. The thorax is usually distinctly segmented and the genital segment is but little wider and longer than the preceding segment, but in the genera *Pseudocycnus*, *Congericola* and *Krøyeria* the genital segment is greatly elongated and is considerably wider than the free segments. In the genus *Lernanthropus* there is considerable fusion of the thoracic segments, and the body is greatly modified by the transformation of the posterior swimming legs into soft laminae, nearly as long as the body itself. In *Pseudocycnus* and *Hatschekia* only two of the anterior thoracic segments are free, the posterior segments being fused with the genital segment to form a body region much longer than the cephalothorax. Another factor which profoundly modifies the general body form is the presence of dorsal plates, or wings, or both. In *Lernanthropus* the dorsal plate which covers the posterior thorax and abdomen is sometimes elongated and widened so much, and is wrapped around the body in such a way, as to give the body the appearance of being clothed in a skirt.

In *Sagum* the dorsal plate is prolonged at the posterior corners into large lobes, which have the appearance of a military cloak draped around the body. In *Norion* the dorsal plate is prolonged

forward at the anterior corners as if to form a pair of large flowing sleeves.

In *Anthosoma*, beside the large dorsal carapace over the cephalothorax, each thorax segment carries a pair of lateral plates or wings, which overlap like tiles on a roof, and give the parasite a peculiarly bizarre appearance.

We may say, then, that the body of a dichelesthiid is made up of four parts or regions, a cephalothorax composed of the head and first thoracic segment fused, a free thorax of from two to four segments, a genital segment either alone or fused with the preceding thorax segments, and an abdomen of one or more segments. For appendages there are two pairs of antennae, a pair of mandibles, two pairs of maxillae, a pair of maxillipeds, and from two to five pairs of swimming legs.

Antennae.—The first antennae are attached to the anterior margin of the cephalothorax, are cylindrical in form, and are composed of a number of short joints placed end to end and plentifully supplied with setae. The number of joints varies considerably, not merely in different genera but also among the species of the same genus; but since the muscles of these first antennae are poorly developed it is difficult, as Heider has said, to determine just how many segments there are. In his figures of the species of *Lernanthropus* he represented the antennae as varying from three to nine segments, and a similar variation has been found in the species described by the present author. Furthermore, the basal joint in some species is enlarged much more than in others. In the different genera the number of joints varies from three in *Pseudocycnus* and *Pseudoclavella* up to nine in *Bassettithia* and fifteen in *Nemesis*, the basal ones being indistinctly separated (fig. 72).

The second antennae are fastened to the ventral surface of the head close to the anterior margin. Being the chief organs of prehension they are large and stout in most of the genera. They are made up of two or three joints, the terminal one in the form of a strong claw which is usually curved, sometimes barbed (*Cybicola*) and sometimes strongly chelate (*Pseudoclavella*, *Dichelesthium*, *Krøyeria*). Rarely these appendages are armed with setae only (*Lamproglena*, *Donusa*, *Ventriculina*). The basal joints are swollen and armed with powerful muscles by means of which the terminal claws can be driven into the flesh of the host (figs. 4, 24, 32, 78, 98).

Mouth parts.—The proboscis is formed of an upper and an under lip, which project from the ventral surface of the head. Near the base the margins of the two lips are tolerably parallel and separated by only a slight distance, but each lip soon begins to taper and in consequence the margins diverge. On either side at the point where

the divergence begins the under lip sends out a lobe, which curves forward and upward around the upper lip and fastens the two securely together in the form of a tube (figs. 75 and 80).

The mandibles originate on the ventral surface of the head outside of the proboscis. Each is somewhat swollen at the base, then tapers into a long and narrow shaft, which passes into the proboscis tube through the opening between the upper and under lips. Inside the proboscis each mandible is widened a little toward the tip and flattened dorso-ventrally and the edges which face each other are finely toothed. In *Lamproglena* and *Lernanthropus* the mandibles are curved like a saber or sickle, with the convex side inward; in *Hatschekia*, *Dichelesthium*, and *Caetrodes* they are straight and have more the shape of a stylet.

The first maxillae vary greatly in different genera; when fully developed, as in *Lernanthropus*, they are biramose, the endopod or palp arising nearer the proboscis and consisting of a tiny process armed with a single seta. The exopod is farther away from the proboscis and is made up of two more or less elongated joints, tipped with two or three setae (fig. 75), but in many of the genera the endopod is entirely lacking and the exopod is destitute of setae. In *Hatschekia* these maxillae consist of small papillae, each armed with three setae, similar to those of the Ergasilidae. In *Anthosoma* both rami are straight spines, the endopod several times the length of the exopod (fig. 5).

The second maxillae are usually smaller and weaker than the maxillipeds. They are normally composed of a swollen basal joint, an elongated and slender second joint, and a small terminal claw, and are prehensile in function. In *Lernanthropus* the concave margin of the claw is armed with two rows of small teeth, and there is a small accessory claw at its base on the inner side (figs. 22 and 25). In *Lamproglena* these maxillae are the chief organs of prehension and each is armed with a very stout curved claw, while the maxillipeds are much smaller and each is tipped with three tiny claws.

The maxillipeds in most of the genera are important organs of prehension and are much stronger and more powerfully developed than the maxillae. They usually consist of a swollen basal joint furnished with strong muscles and a curved terminal claw. In some genera these claws are simple and shut down against the side of the basal joint, as in *Donusa*, *Pseudoclavella*, and *Lernanthropus*. In other genera the terminal claw is barbed or furnished with one or more teeth on the concave margin, as in *Cybicola*, *Pseudocycnus*, and *Congericola*, and in *Nemesis*, *Eudactylina*, *Dichelesthium*, and *Anthosoma* there are outgrowths upon the basal joint into which the tip of the claw fits, making it virtually a chela (fig. 82). *Dichelesthium* is the only genus in which both the second antennae and the

Table showing relative structure of antennae and mouth parts.

Genus.	First antenna.	Second antenna.	First maxilla.	Second maxilla.	Maxilliped.
Anthosoma	6 joints	3 joints; uncinate	Spines biramose	3 joints; uncinate	2 joints; chelate.
Bassettithia	9 joints	2 joints; uncinate	Spines biramose	Unknown	Unknown.
Caetrodes	5 joints	2 joints; uncinate	2 joints; uniramose	2 joints; uncinate	2 joints; uncinate.
Congericola	6 joints	2 joints; uncinate	1 joint; uniramose	1 joint; setose	3 joints; uncinate.
Cybicola	7 joints	Barbed claw	2 joints; uniramose	2 joints; uncinate	Barbed claw.
Dichelesthium	8 joints	3 joints; chelate	Biramose	2 joints; uncinate	2 joints; chelate.
Donusa	6 joints	2 joints; setose	1 joint; uniramose	2 joints; uncinate	2 joints; uncinate.
Ergasilina	5 joints	2 joints; uncinate	Unknown	2 joints; uncinate	2 joints; uncinate.
Eudactylina	4–8 joints	3 joints; uncinate	Spines biramose	3 joints; uncinate	2 joints; chelate.
Hatschekia	3–5 joints	2 joints; uncinate	1 joint; uniramose	Lacking	2 joints; uncinate.
Krøyeria	7–8 joints	3 joints; chelate	2 joints; uniramose	3 joints; setose	2 joints; uncinate.
Lamproglena	Fused joints	4 joints; setose	Unknown	2 joints; uncinate	2 joints; uncinate.
Lernanthropus	6–7 joints	2 joints; uncinate	2 joints; uniramose	2 joints; uncinate	2 joints; uncinate.
Nemesis	11–15 joints	2 joints; uncinate	Spines biramose	3 joints; setose	[1] Uncinate; [2] chelate.
Norion	6 joints	2 joints; uncinate	2 joints; uniramose	2 joints; uncinate	2 joints; uncinate.
Peniculisa	Fused joints	2 joints; uncinate	Lacking	Lacking	2 joints; uncinate.
Pseudoclavella	3 joints	2 joints; chelate	2 joints; uniramose	3 joints; uncinate	3 joints; uncinate.
Pseudocycnus	3 joints	2 joints; uncinate	3 joints; uniramose	3 joints; setose	Barbed claw.
Sagum	6 joints	2 joints; uncinate	2 joints; uniramose	2 joints; uncinate	2 joints; uncinate.
Ventriculina	4 joints	3 joints; setose	Unknown	2 joints; setose	2 joints; uncinate.

[1] Female. [2] Male.

maxillipeds are chelate. In the other genera, when one of these appendages is chelate, the other will be found to be armed with simple claws or often only with setae. *Lamproglena*, as noted above, is the chief exception, and here the second maxillae and maxillipeds have apparently changed places. The preceding table has been compiled for the purpose of contrasting the structure of the antennae and the mouth parts, with the exception of the mandibles, in the various genera. The available data on the structure of the mandibles at the present time is too meager to warrant their inclusion in the table.

Swimming legs.—The swimming legs vary greatly in number and structure. Most of the genera have four pairs, but in *Eudactylina*, *Nemesis*, *Lamproglena*, and *Donusa* there is a fifth pair. In the first three the fifth leg consists of a single laminate process, but in *Donusa* each fifth leg is biramose and the rami are three jointed, like the other four pairs. In addition to the genera just named the first four pairs of legs are also biramose in *Congericola*, *Pagodina*, *Krøyeria*, *Peniculisa*, and *Sagum*, nine genera in all out of the twenty in the family. In *Donusa* and *Krøyeria* each ramus is three jointed, but in the other genera the number of joints varies, no two genera being alike. In *Bassettithia* the first three pairs of legs consist of basal joints only, while the fourth pair are biramose, with one-jointed rami. In *Cybicola* and *Ventriculina* there are only three pairs of legs, the first pair biramose, with one-jointed rami, the second and third pairs uniramose. In *Pseudoclavella* the first two pairs are biramose, the third and fourth pairs uniramose. In *Pseudocycnus* the first and fourth pairs are uniramose and are made up of the basipod only, the second pair is biramose, the rami one jointed, and the third pair is uniramose and two jointed. In *Hatschekia* and *Caetrodes* only the first two pairs of legs are present, each biramose and the rami two jointed. In *Dichelesthium* the first two pairs are biramose and the third pair uniramose, while the fourth pair is entirely lacking. In *Lernanthropus* the first two pairs are biramose with one-jointed rami, while the third and fourth pairs are modified into long cylindrical processes, apparently concerned in respiration. In *Anthosoma* the first three pairs are replaced by foliaceous plates and the fourth pair is lacking, while in *Norion* apparently only the first pair is present, and these are uniramose and one jointed. In the following table these differences are brought out clearly. The most noticeable feature is the prevailing lack of uniformity. The absence of fifth legs is the only character that approaches regularity and even there twenty percent of the genera show exceptions. It almost seems as if the various characters must have been shuffled for each genus separately in order to produce such prevalent and radical discrepancies.

Genus.	First leg.	Second leg.	Third leg.	Fourth leg.	Fifth leg.
Anthosoma	Single foliaceous plate.	Single foliaceous plate.	Single foliaceous plate.	Wanting	Wanting.
Bassettithia	Uniramose; basipod only.	Uniramose; basipod only.	Uniramose; basipod only.	Biramose; rami one-jointed.	Wanting.
Caetrodes	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Wanting	Wanting	Wanting.
Congericola	Biramose; rami jointed	Biramose; rami jointed	Biramose; rami jointed	Biramose; rami jointed	Wanting.
Cybicola	Biramose; rami one-jointed.	Uniramose; two-jointed.	Uniramose; one-jointed.	Wanting	Wanting.
Dichelesthium	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Biramose; rami one-jointed.	Uniramose; rami one-jointed.	Wanting.
Donusa	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.
Eudactylina	Biramose; rami jointed	Biramose; rami jointed	Biramose; rami jointed	Biramose; rami jointed	Uniramose; one-jointed.
Hatschekia	Biramose; rami jointed	Biramose; rami jointed	Wanting	Wanting	Wanting.
Krøyeria	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Biramose; rami three-jointed.	Wanting.
Lamproglena	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Biramose; rami two-jointed.	Uniramose; one-jointed.
Lernanthropus	Biramose; rami one-jointed.	Biramose; rami one-jointed.	[1] Uniramose; [2] biramose; one-jointed.	Biramose; rami one-jointed.	Wanting.
Nemesis	Biramose; rami jointed	Biramose; rami jointed	Biramose; rami jointed	Biramose; rami jointed	Uniramose; one-jointed.
Norion	Uniramose; one-jointed.	Wanting	Wanting	Wanting	Wanting.
Ergasilina	Biramose; rami jointed	Biramose; rami jointed	Biramose; rami jointed	Biramose; rami jointed	Wanting.
Peniculisa	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Wanting.
Pseudoclavella	Biramose; rami jointed	Biramose; rami jointed	Uniramose; one-jointed.	Uniramose; one-jointed.	Wanting.
Pseudocycnus	Uniramose; one-jointed.	Biramose; rami one-jointed.	Uniramose; two-jointed.	Uniramose; one-jointed.	Wanting.
Sagum	Biramose; rami one-jointed.	Biramose; rami one-jointed.	Biramose; rami laminate.	Biramose; rami spatulate.	Wanting.
Ventriculina	Biramose; rami two-jointed.	Uniramose; two-jointed.	Uniramose; two-jointed.	Wanting	Wanting.

[1] Female. [2] Male.

Integument.—In none of the genera is the skin hardened into inflexible chitin, as occurs in so many of the Lernaeidae. The modifications of the skin, called variously carapace, dorsal, or lateral plates, wings, lobes, etc., are often hardened into chitin, as in *Anthosoma*, *Nemesis*, and *Dichelesthium*, but there are also some genera in which they remain soft, as in *Lernanthropus* and *Bassettithia;* but in sections that are double-stained the skin always takes the red eosin, but refuses the second color, showing that it has been modified even though it remains soft. Such a section demonstrates that the skin is made up of very thin layers packed closely together. Moreover, it is not uniform in thickness, but varies greatly in different parts of the body. It is nearly always thicker upon the appendages than upon the body itself, and the framework which supports the various appendages, together with the rods and bands which connect the bases of each pair of appendages across the median line, and the framework around the sex openings appear to be formed by a thickening of the skin. A comparison of the different layers of the skin shows that the outer layers are denser and more homogeneous in structure, darker in color, and more strongly refractive than the inner layers. Consequently Heider was led to the conclusion that the increase in thickness takes place by the addition of layers from the inside, which seems probable. Another notable difference in thickened portions of the skin is that the inner layers often show a distinct granulation and sometimes an irregular striping, perpendicular to the surface. Through this skin open excretory ducts leading from the inner chitinogen layer. So far as observed these appear to be usually cylindrical and uniform in diameter, rather than funnel shaped as in the Lernaeidae. They are scattered everywhere over the skin in great numbers, but are especially numerous upon the head and the free edges of the carapace and dorsal plates. But beside these slender ducts there are a few along the edge of the dorsal carapace, which are funnel shaped and whose diameter is much larger. And the inner or larger end of the funnel is oval rather than circular in outline. A pair of large ducts open between the bases of the maxillipeds and a similar pair on either side near the bases of the first and second antennae.

The outgrowths of the skin are of three kinds. First, there are processes of the skin itself, soft in texture, hollow, and filled with the chitinogen layer from the inside of the body. These are found in considerable numbers on the antennae, especially on the terminal joints, and may be designated as tactile processes. Here also belong the large setae on the anal laminae, which are hollow and whose lumen is filled with tissue from the inside of the body. A second group comprises the tactile setae which arise from small warts placed

in an invagination of the skin. These setae are solid, but the warts are partially hollow, and to them slender cords of granular protoplasm lead through the skin. The third group includes the hairs which appear in various places on the skin and the setae that are found on the appendages. These are solid, they arise directly from the surface of the skin and not from a wart or process, and they are not connected in any way with the interior of the body through the skin.

Under the skin is found a layer of tissue which has been called by Hartmann the chitinogen layer and by Heider the matrix, and which varies considerably in the different genera. In *Lernanthropus* Heider has described this as not a continuous cellular layer, but instead a protoplasmic ground substance without any distinction of cells, but with small nuclei and granules scattered through it, giving it a granular appearance. In *Dichelesthium* the chitinogen layer varies greatly in thickness, being reduced to a membrane at and near the joints between the body segments, but increased many times in the center of the segments. Here also the cells are not separated by walls or membranes, but the nuclei are scattered through a common ground substance. There is, however, on the side next to the skin a row of nuclei, slightly larger than the others and placed very close together, which stand out with especial distinctness and have every appearance of a pavement epithelium whose tiny component cells have been completely fused. At the joints the chitinogen layer is made up of this pavement epithelium alone, but elsewhere the ground substance is greatly thickened and gathered into rounded masses of varying size, through which nuclei are scattered indiscriminately (fig. 105). In *Nemesis* the skin itself is very distinctly striated transversely and the matrix beneath it is so thin that in many places it can only be distinguished with difficulty. It is thicker on the ventral than on the dorsal surface and enters the large basal joints of the swimming legs, but even here no nuclei or cell walls can be seen.

Inside the matrix is the connective tissue which surrounds all the organs and holds them in place like a mesentery. It is made up of a delicate network of fibers, which are usually branched where they are attached to the inner surface of the matrix. In among the fibers may be seen here and there small connective tissue cells with a distinct nucleus. This tissue enters the large basal joints of the swimming legs in *Nemesis*, and the modified laminae of the third and fourth legs in *Lernanthropus*, filling the entire cavity, except for the meshes between the fibers of the tissue itself and the portion already filled by the matrix. In the laminate legs of *Lernanthropus* the matrix is so thin that the connective tissue fibers penetrate through

it and are attached to the inside of the skin itself. They thus serve as stays or supports of these legs, rendering them less liable to collapse.

INTERNAL MORPHOLOGY.

General statement.—Inside the skin are found the muscles for moving the body and its various appendages. The digestive system consists of a mouth, an esophagus, usually inclined forward, a straight intestine, and a short rectum. The nervous system consists of two ganglia, one above and one below the esophagus, a ventral nerve trunk, divided posteriorly, and nerves extending to various parts of the body. The reproductive system is made up of paired ovaries or testes, oviducts, or sperm ducts leading back along the lateral margins, cement glands between the oviducts and the body wall, sperm receptacles in the female and spermatophore receptacles in the male. The excretory system consists of a number of small glands distributed in various parts of the body, the ducts leading from them opening to the surface through the skin.

Musculature.—The most important muscle groups are those including the longitudinal muscles of the dorsal and ventral surfaces, the muscles which move the various appendages, and the dorsoventral muscles. The largest and longest muscles in the body are two connected with the second antennae. Each is attached to the distal end of the basal joint of the antenna and has its origin near the posterior margin of the cephalothorax. At its origin and for a third of its length it is bifid, then the two branches unite into a single large band. Inside of these muscles in the anterior part of the cephalothorax are two much smaller ones curved like parenthesis marks, which are connected with the first antennae. Behind the origin of these curved muscles on either side are small bundles of fibers which have their origin on the dorsal surface and run downward and forward to the base of the mouth tube. Behind these in the posterior center of the cephalothorax are two pairs of narrow longitudinal muscles which run back through the second segment and are attached to its posterior margin. Outside of these in the second segment are two other longitudinal muscles on either side, which run from the first segment through the second into the anterior part of the third segment. From this last point to the middle of the fifth segment there are two pairs of muscles on either side. From the middle of the fifth to the genital segments there are three muscles on either side, and in the posterior part of the genital segment and the abdomen there is only one.

On the ventral surface there is but a single muscle on either side of the midline, which is broken at places corresponding to the breaks in the dorsal muscles.

In connection with the various appendages it may be noted that their musculature varies according to their importance and function. For the first antennae there are only a few weak muscles, except in *Eudactylina*, where the basal joints are prehensile and need strong muscles. The second antennae are supplied with powerful muscles; in addition to the long dorsal ones already mentioned there are smaller ones on the ventral surface of the head and others within the joints; those which flex the claw of the chela are especially well developed. In *Ergasilina*, *Krøyeria*, and *Congericola* the musculature of the second antennae is even better developed than in *Dichelesthium*.

For the mouth tube there is a pair of flexors and a pair of extensors, both originating on the ventral surface of the head. The muscles connected with the mandibles are weak; in *Lernanthropus* Heider considered it more or less doubtful if there was any muscle running to the mandibles. There are none connected with the first maxillae in any of the species examined by the present author and none have been mentioned by any investigator. In connection with the second maxillae in *Dichelesthium* there are three pairs of muscle bands, originating on the dorsal surface and running to the basal joint of the appendages. One of each pair originates outside and the other inside of the long muscle going to the second antennae. In *Krøyeria*, *Nemesis*, and *Donusa* the second maxillae are well developed and demand a good muscle supply.

The maxillipeds in all the genera are powerful prehensile organs but they are exceptionally developed in *Eudactylina*, *Nemesis*, *Lernanthropus*, and *Cybicola*. In the two former they are true chelae and in the two latter the terminal claw is toothed. The basal joint of these appendages in each of these genera is filled with strong flexors and extensors, which control the movements of the terminal claw or chela.

The usual muscles are found in connection with the swimming legs in all the genera, but when the legs are reduced to a single ramus, as in *Dichelesthium*, *Pseudoclavella*, and *Ergasilina*, or to mere papillae bearing setae, as in *Pseudocycnus* and *Cybicola*, or wholly disappear, as in *Hatschekia*, *Caetrodes*, and *Norion*, we find a corresponding reduction or disappearance in the musculature. Those genera like *Lernanthropus*, *Anthosoma*, and *Sagum*, in which the swimming legs have been transformed into laminae, show considerable musculature. In *Lernanthropus gisleri*, for example, the first pair of laminae (third legs) show finely branched muscles whose fibers form a definite network over the entire lamina. In other species also the muscles often run to the very end of the lamina.

In connection with the rectum most genera show the dilator muscles which serve in rectal respiration.

The dorsoventral muscles are chiefly isolated bundles along the sides of the thorax and genital segment, which assist in the passage of the eggs along the oviducts.

Digestive canal.—The general form and position of the digestive canal have already been stated. In *Lernanthropus* the esophagus passes inward and backward straight to the ventral surface of the stomach, which it enters close to the anterior end. In *Nemesis* and *Dichelesthium* there is a sharp bend or flexure in the esophagus, the outer three-fifths pointing forward and the inner two-fifths backward, but it enters the ventral surface of the stomach at the same place, close to the anterior end (fig. 71). The digestive tube is widened considerably in the head, then is narrowed through the thorax and is abruptly contracted in the abdomen. The length of the widened or stomach portion varies greatly in different genera. In *Lernanthropus* and *Dichelesthium* the enlarged portion runs through the entire body, remaining about the same diameter, and is abruptly narrowed to the rectum on entering the abdomen. In *Hatschekia*, *Eudactylina*, and *Lamproglena* the widened portion begins to narrow somewhere in the thorax, and from there tapers gradually to the anus. There is no definite place where it can be said that one part ends and another begins. In *Nemesis* the intestine retains its wide diameter through the fourth thorax segment and is then rather abruptly narrowed in the fifth segment, after which it tapers gradually to the anus without any definite rectum. In *Congericola*, *Krøyeria*, and *Cybicola* the stomach narrows into the intestine at the posterior margin of the head, remains narrow through the free thorax segments, and then widens again in the fused posterior body. The walls of the digestive tube contain both longitudinal and transverse muscles, and by their rhythmic contraction and relaxation peristaltic movements run backwards and forwards over the entire canal. By this means the canal contents are pushed back and forth, a portion being thoroughly digested while the rest is excreted.

The epithelium in the esophagus and rectum is thin, and is made up of smaller cells nearly uniform in size. In the enlarged portions the epithelium is considerably thicker, and, especially in the anterior stomach, contains many digestive cells, which are much larger than the rest of the epithelial cells (fig. 68).

Female reproductive system.—In the females of some genera like *Hatschekia*, *Lernanthropus*, *Peniculisa*, *Eudactylina*, *Pseudocycnus*, etc., the ovaries are situated in the anterior thorax or the anterior part of the fused posterior body. In other genera like *Nemesis*, *Dichelesthium*, etc., the ovaries are in the posterior part of the head, directly above the stomach. The oviducts lead from the anterior ends of the ovaries outward, downward, and backward, and are convoluted to

the right and left in the space between the digestive tube and the lateral walls of the body.

The ovaries are covered with a thick connective tissue coat, inside of which are the egg glands twisted into many folds and windings. The eggs pass forward in the ovary and gradually increase in size; on entering the oviduct they increase more rapidly and attain their maximum within the first convolution. They are then scattered throughout the rest of the oviduct without any order and are not flattened at all. In this they present a strong contrast to the Lernaeidae, whose eggs are arranged in a single row like flattened coins and in a straight oviduct without convolutions.

The cement glands are elongated and cylindrical or club-shaped. In *Lernanthropus* the cement glands are club-shaped and lie above the oviducts on either side of the intestine and close to its dorsal wall. They reach forward to the first convolution of the oviduct in the third thoracic segment. The glandular portion includes practically the whole of the organ but is unsegmented, while the ducts are very short and open into the oviduct close to the vulvae. In *Eudactylina* the glands are similarly situated but extend forward only to the fifth thoracic segment and the club-shaped glandular portion is distinctly segmented (fig. 76). In *Hatschekia*, *Dichelesthium*, and *Pseudocycnus* the cement glands are slender cylinders, ventral to the oviducts and unsegmented (fig. 89).

The semen receptacles vary in size and shape, as well as position. In *Lernanthropus* they are ventral to the intestine, elongate, and club-shaped, and they reach forward nearly as far as the cement glands. In *Dichelesthium* and *Pseudocycnus* they are short and triangular, on the ventral surface of the body cavity, the pointed end anterior, the posterior margin three-lobed. The receptacle opens into the oviduct on either side close to the vulva (fig. 89).

Male reproductive system.—The situation of the testes corresponds to that of the ovaries; in some genera they are in the anterior portion of the thorax or of the fused posterior body, and in other genera in the posterior portion of the cephalothorax. Similarly also the sperm ducts are given off from the anterior ends of the testes and pass downward, outward, and backward in more or less intricate convolutions along the sides of the thorax. In *Lernanthropus* they first turn inward and backward along the dorsal surface of the intestine as far as the genital segment, where they almost come together on the midline. They then make a complete turn and run forward again alongside of and close to the first fold to a point opposite the anterior end of the testes. They now turn outward, downward, and backward along the sides of thorax, sending convolutions into the bases of the modified third and fourth legs, and then turn forward to the anterior ends of the spermatophore receptacles (fig. 37).

Posteriorly the walls of the ducts are thickened and serve as glands for the secretion of the cement substance which forms the walls of the spermatophores. In *Dichelesthium*, *Nemesis*, and *Eudactylina* the general course of the ducts is the same, but the first long fold is omitted and there are not as many convolutions.

Inside the spermatophore receptacles the sperms are gathered into the spermatophores, which are afterward attached to the females. These spermatophores are ellipsoidal and in *Lernanthropus* the ends of the discharging tubes, where they are applied to the vulvae of the female, are swollen into large brown spherical receptacles, which remain in place on the vulvae long after the spermatophore itself has disappeared (fig. 104). In *Dichelesthium* the spermatophores are narrower ellipsoids and are attached side by side on the midline of the abdomen close to the genital segment. Their discharge tubes then cross each other and enter the vulva on the opposite side.

Nervous system.—The nervous system includes first a supra- and an infra-esophageal ganglion. The former takes more or less the shape of a flattened cone, and from the anterior end nerves are sent to the first and second antennæ and the anterior part of the head. The pair running to the first antennæ originate close together at the center of the anterior end of the ganglion in *Lernanthropus;* they are apparently fused into a single strand for some distance, then separate and enter the base of each antenna. In *Dichelesthium* they originate at the corners of the anterior end and are divergent. Outside of this first pair arises another nerve on either side which goes to the second antenna. The infraesophageal ganglion is considerably elongated and tapers gradually backward into the ventral nerve trunk. From it branches extend to the mouth parts, the swimming legs, and the reproductive organs.

The ventral nerve trunk runs back to the fifth thoracic segment and there divides, the two branches separating a little and continuing through the fifth and genital segments. From the ventral trunk branches are given off to the various muscles of the thorax, and from the two posterior branches of the trunk itself are supplied the nerves leading to the muscles controlling the vulvae and semen receptacle in the female, and the spermatophore receptacles and ejaculatory ducts in the male. They also control the dilator muscles of the rectum during respiration (see fig. 71).

Vascular system.—Since only a single genus. *Lernanthropus*, possesses anything in the way of a vascular system, the description of it is reserved for that genus alone. In other genera circulation is accomplished by means of the peristaltic movements of the digestive canal together with those concerned in rectal breathing. In most genera, however, there is very little movement of the fluid contents of the body cavity.

ONTOGENY.

Nothing is known of the development of any genus beyond the nauplius stage. Such nauplii as have been obtained will be described under the various species to which they belong.

SYSTEMATIC DESCRIPTIONS.

Family DICHELESTHIIDAE.

Anthosomadae BAIRD, British Entomostraca, 1850, p. 296.

Caligidae, Race I LEACH, Dictionaire des Sciences Naturelles, vol. 14, 1819. p. 524.

Caligidae, Race I DESMAREST, Des Crustacés, 1825, p. 334.

Ergasilina, Division B BURMEISTER, Acta Acad. Caes. Leop. Carol. Nat. Cur., vol. 17, 1833, p. 328.

Ergasilina, Division B KRØYER, Naturhistorisk Tidsskrift, vol. 1, 1837, p. 198.

Dichelestidae MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, p. 481.

Lernaeiformidae NORDMANN, Mikrographische Beiträge, pt. 2, 1832, p. 55.

Dichelestini NORDMANN, Bulletin Soc. Imp. des Nat., Moscou, vol. 37, 1864, p. 474.

Dichelestina HELLER, Reise der *Novara*, 1865, p. 212.

Dichelesthiina GERSTAECKER, Bronn's Klassen und Ordnungen, vol. 5, 1871, p. 724.

Dichelesthiidae M. J. RATHBUN, Fauna of New England, 1905, p. 97.

Dichelesthiidae BRIAN, Copepodi Parassiti dei Pesci d'Italia, 1906, p. 62.

Dichelestiidae CALMAN, Lankester's Zoology, pt. 7, fas. 3, 1909, p. 103.

Dichelestiidae T. and A. SCOTT, British Copepoda, 1912, p. 105.

Family characters of female.—General body form long and narrow; head fused with first thorax segment and the two covered with a carapace; free thorax segments usually simple, but sometimes furnished with wings or dorsal plates or both; abdomen small and unsegmented; egg strings long and filose; eggs uniseriate, sometimes strongly flattened, sometimes swollen into separate spheres.

Two pairs of antennae, first pair slender and setose, second pair stout and uncinate; mouth parts similar to those of the Caligidae; one pair of mandibles, two pairs of maxillae, one pair of maxillipeds; usually four pairs of swimming legs, third and fourth pairs sometimes transformed into lamelliform plates, or rudimentary, or even lacking.

Family characters of male.—Smaller than the female, but not a pygmy; head and first thorax segment fused and covered with a carapace; remaining thorax segments fused and sometimes covered with a dorsal plate, but never furnished with wings; abdomen minute and unsegmented.

Antennae and mouth parts similar to those of the female; swimming legs also similar, with sometimes a fifth pair on the genital segment.

This family is chiefly parasitic upon salt-water fish, but a few species, like the one for which the family is named, are found upon fish that enter fresh water.

KEY TO SUBFAMILIES AND GENERA.

1. One or more body regions furnished with plates or wings, or both. ANTHOSOMINAE. 2
1. No plates or wings on any body region ---------- 5
2. All the swimming legs replaced by lamellar plates ---------- 3
2. The two anterior pairs of legs of the usual biramose form, the posterior pairs sometimes modified ---------- 4
3. Cephalothorax with a divided carapace; swimming legs represented by three pairs of large wings ---------- *Anthosoma* Leach, 1816, p. 23
3. Free thorax and abdomen covered with separate dorsal plates; swimming legs fused into a single plate ---------- *Norion* Nordmann, 1864, p. 26
4. Cephalothorax with large carapace extending over the free segments; only two pairs of legs, first and second, with filiform, two-jointed rami. *Caetrodes* Wilson, 1906, p. 27
4. Carapace produced into lateral wings; posterior body covered with a single dorsal plate, with large lateral lobes; third and fourth legs transformed into laminae ---------- *Sagum* Wilson, 1913, p. 28
4. Lateral margins of carapace curled over ventrally; dorsal plate of posterior body without lobes; third and fourth legs with elongate, fleshy rami. *Lernanthropus* Blainville, 1822, p. 30
5. All four pairs of swimming legs present and equally developed. EUDACTYLINAE. 6
5. All four pairs of swimming legs present, but one or more of them modified or rudimentary ---------- PSEUDOCYCNINAE. 12
5. One or more pairs of swimming legs lacking; those present usually modified or rudimentary ---------- DICHELESTHIINAE. 13
6. Second antennae armed with a stout chela, cheliform ---------- 7
6. Second antennae armed with a simple claw, uncinate ---------- 8
6. Second antennae armed with setae only, setiferous ---------- 11
7. Genital segment produced into a wide and flattened posterior process on either side of the abdomen ---------- *Peniculisa* Wilson, 1917, p. 53
7. No posterior processes, but the genital segment and abdomen much elongated and narrow ---------- *Krøyeria* Beneden, 1853, p. 54
8. Legs all uniramose; claw on second antennae large but simple and not a chela. *Ergasilina* Beneden, 1851, p. 56
8. Legs all biramose; claw on second antennae much smaller ---------- 9
9. Two anterior free thorax segments short and narrow, posterior ones elongate and widened; exopods of swimming legs three-jointed, endopods one-jointed ---------- *Congericola* Beneden, 1854, p. 57
9. Free thorax segments all the same length and width; exopods and endopods of swimming legs with the same number of joints ---------- 10
10. Rami two-jointed in the female; maxilliped with simple claw. *Nemesis* Risso, 1826, p. 58
10. Rami three-jointed in the female; maxilliped with a large and stout chela. *Eudactylina* Beneden, 1853, p. 65
11. Abdomen as long as rest of body; rami of swimming legs one-jointed; anterior thorax segments shorter and narrower than posterior ones. *Lamproglena* Nordmann, 1832, p. 71

11. Abdomen very short; rami of swimming legs three-jointed; anterior thorax segments longer and wider than posterior ones.
Donusa Nordmann, 1864, p. 72

12. First three pairs of legs mere stumps; fourth pair with two short unsegmented rami________________________*Bassettithia*, new genus name, p. 72

12. First two pairs of legs biramose, rami two-jointed; last two pairs mere stumps without rami____________*Pseudoclavella* Basset-Smith, 1898, p. 73

12. First and third pairs of legs uniramose, unsegmented; second pair biramose, rami unsegmented; fourth pair mere stumps without rami.
Pseudocycnus Heller, 1865, p. 74

13. First two pairs of legs biramose, rami two-jointed; third and fourth pairs wanting or reduced to setae; second antennae uncinate.
Hatschekia Poche, 1902, p. 81

13. First two pairs of legs biramose, rami one-jointed; third pair lamellar; fourth pair lacking; second antennae chelate.
Dichelesthium Hermann, 1804, p. 85

13. First legs biramose, rami one-jointed; second pair uniramose; third pair mere stumps without rami; fourth pair lacking; second antennae large but not chelate____________________________*Cybicola* Basset-Smith, 1898, p. 88

13. First legs biramose, rami two-jointed; second and third pairs uniramose, rami one-jointed; fourth pair lacking; second antennae with setae only, no chela or claw_____________________*Ventriculina* Basset-Smith, 1903, p. 89

Rejected genera.—In 1837 Krøyer published[5] the description of a new species of parasitic copepod, which he named *Aethon quadratus*. It was founded on a single specimen taken from the gills of a West Indian *Serranus*. For discussion of this genus see p. 30.

In 1860[6] Lubbock described and figured a new species which he called *Baculus elongatus*. He said that it resembled the Caligidae more than the Dichelesthiidae, to which its long antennae would ally it. It has since been proved to be a stage in the development of *Pennella*, and hence becomes a Lernaean.

The genus *Clavella* is rightly a Lernaeopod, as was explained[7] but it has been used by many authors to designate species belonging to the present family. To obviate the difficulty of having the same genus in two different families Poche suggested the name *Hatschekia* for such species as belong to the Dichelesthiidae, and for these species the name *Clavella* becomes a synonym.

A genus called *Cycnus* was established by Milne Edwards[8] to include a single species, but the name had already been used by Hubener for a genus of Lepidoptera in 1816 and hence cannot be retained for the copepod genus. In 1854 P. J. van Beneden described a genus and species which he claimed as new and to which he gave the name *Congericola pallida*.[9] This has proved to be the same generically as Milne Edwards's specimens, but differs from them specifically. Ac-

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[5] Naturhistorisk Tidsskrift, vol. 1, p. 257, pl. 2, fig. 9; pl. 3, fig. 1 *a–c*.
[6] Trans. Linnaean Soc., vol. 23, 1860, p. 190, pl. 29, figs. 40 and 42.
[7] Proc. U. S. Nat. Mus., vol. 47, 1915, p. 666.
[8] Histoire Naturelle des Crustacés, vol. 3, 1840, p. 495.
[9] Bulletin Acad. de Belgique, vol. 21, pt. 2, p. 583.

cordingly Beneden's genus name must be substituted for that of Milne Edwards, and the type of the genus becomes *Congericola pallida* Beneden.

Nordmann in 1832 described[10] a genus and species called *Epachthes paradoxus*. The next year Burmeister[11] showed that Normann's genus was a synonym of *Lernanthropus*.

In January, 1898, Bassett-Smith proposed a new genus to be known as *Helleria*, with the type species *armata*.[12] This name had already been used three times for crustacean genera which were not copepods. This fact being called to his attention, Bassett-Smith in November of the same year changed the name to *Cybicola*.[13]

Gerstaecker published[14] a new genus of Siphonostoma called *Lonchidium*, with the single type species *aculeatum*. This proved to be generically the same as Beneden's *Krøyeria*, which had appeared in the preceding year. This fact was recognized by Nordmann in 1864,[15] but it was misinterpreted by Bassett-Smith,[16] who reversed the precedence and made *Krøyeria* a synonym of *Lonchidium*.

Risso in 1816 published a Histoire Naturelle des Crustacès des Environs de Nice, in which he described (p. 162) a new species of the genus *Caligus*, *C. imbricatus*. Leach later in the same year established in the Supplement to the Encyclopedia Brittanica (vol. 1, p. 406) a new genus of Entomostraca, which he called *Anthosoma smithii*. Both Risso's specimens, which were examined by Leach, and those of Leach himself were subsequently shown to be the same as had been described by Abildgaard in 1794 as "*Caligus crassus*."[17] Leach's generic distinction, however, was valid, and hence the species became *Anthosoma crassum* (Abildgaard); but in spite of this Risso again described his species as new in Histoire Naturelle des principales de l'Europe meriodionale (vol. 5, 1826, p. 136), this time under the name *Otrophesia imbricata*, which, of course, becomes a synonym of *Anthosoma crassum*.

P. J. van Beneden established a new species and genus of parasitic copepod,[18] which he named *Pagodina robusta*. This is shown on page 60 to be identical with the genus *Nemesis* and becomes a synonym of the latter.

For Nordmann's proposed new genus, *Stalagmus*, see page 36.

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[10] Mikrographische Beitrade, vol. 2, p. 45.
[11] Acta Acad. Caes. Leop. Carol. Nat. Cur., vol. 17, p. 307.
[12] Ann. Mag. Nat. Hist., ser. 7, vol. 1, p. 10.
[13] Idem, vol. 2, p. 371.
[14] Archiv für Naturgeschichte, vol. 20, 1854, p. 185.
[15] Bull. des Nat. Moscou, vol. 37, p. 468.
[16] Proc. Zool. Soc. London, 1899, p. 473.
[17] Skrivter af naturhistorie Selskabet, Kjobenhavn, vol. 3, pt. 2, p. 46.
[18] Bull. Acad. Roy. Belgique, vol. 20, 1853, p. 482.

Genus ANTHOSOMA Leach.

Caligus (part) ABILDGAARD, 1794. *See under Anthosoma crassum.*

Generic characters of female.—General body form short and rather stout. Cephalothorax covered with an ovid carapace more than half the entire length of the body. Genital segment and abdomen entirely covered dorsally by two large elytra, which overlap considerably along the midline; also, entirely concealed ventrally by three pairs of overlapping foliaceous swimming legs. Abdomen small and one-jointed. Egg strings narrow and three times the body length. First antennae slender, six-jointed; second antennae stout, jointed, terminating in a strong claw; maxillipeds short and very strong, with a powerful terminal claw.

Generic characters of male.—General body form and appendages very similar to those of the female, but the genital segment and abdomen have no dorsal elytra and so are visible in dorsal view. The first two pairs of foliaceous swimming legs have one-jointed rami in the notches on the inner margins.

Type of the genus.—*Anthosoma crassum* (Abildgaard), monotypic.

Remarks.—This genus has but the single species and it is easily recognized by the dorsal elytra and the foliaceous swimming legs, since they are quite different from anything found in other genera. In spite of the fact that the genus is so old and so well known there are still some details of structure which have never been presented.

ANTHOSOMA CRASSUM (Abildgaard).

Plate 1, figs. 1–8.

Caligus crassus ABILDGAARD, Skrivter af naturhistorie Selskabet, Kjøbenhavn, vol. 3, 1794, p. 46, pl. 5, figs. 1–3.

Caligus imbricatus RISSO, Histoire naturelle des Crustacés des environs de Nice, 1816, p. 162, pl. 3, fig. 13.

Anthosoma smithii LEACH, Supplement to 4th, 5th, and 6th ed. Encyclopedia Britannica, vol. 1, 1816, p. 406, pl. 20, figs. 1–6.

Otrophesia imbricata RISSO, Histoire naturelle des principales de l'Europe méridionale, vol. 5, 1826, p. 136.

Anthosoma crassum GOULD, A Report on the Invertebrata of Massachusetts, 1841, p. 340.

Anthosoma crassum STEENSTRUP and LÜTKEN, Kongel. Danske Vidensk. Selsk. Skrifter, ser. 5, vol. 5, 1861, p. 397, pl. 12, fig. 24.

Anthosoma crassum T. and A. SCOTT, British Parasitic Copepoda, 1913, p. 108, pl. 23, figs. 5–6.

Host and record of specimens.—A single female from the gills of the sand shark, *Carcharias littoralis*, at Woods Hole has received Cat. No. 6039, U.S.N.M. Another female from the gills of the porbeagle shark, *Lamna cornubica*, probably from Woods Hole, bears Cat. No. 8108 U.S.N.M. A finely preserved male from the mouth of

a sand shark, *Carcharias littoralis*, at Woods Hole was taken by Dr. Edwin Linton and has been given Cat. No. 53570, U.S.N.M. Two females and a male from the mouth of a mackerel shark, *Isurus oxyrhynchus*, were taken June 17, 1888, by Vinal Edwards at Woods Hole and have been given Cat. No. 53571, U.S.N.M.

Specific characters of female.—In addition to what has just been given under the generic characters we may note the following: The carapace covering the cephalothorax is yellowish brown, deeper in color through the center and paling towards the margins. The antennal area is separated from the rest of the head by well-defined marginal invaginations and by a somewhat indistinct dorsal groove. In the larger and more mature females there is usually in invagination at the center of the posterior margin of the carapace, sometimes extending quite a distance as a triangular slit. In younger females and sometimes in older ones the margin is entire. The carapace projects backward over the free thorax and overlaps the genital segment. On the dorsal surface of the fourth segment is a pair of large elytra which entirely cover the posterior part of the body and overlap along the median line. These are white in color like the membraneous legs and are similarly covered with minute transparent dots or depressions.

The genital segment is oblong with nearly parallel margins, the proportion of the length to the width being as 4 to 3. The egg strings are attached to its posterior margin, considerably below the dorsal surface, side by side on the median line.

The abdomen is attached to the ventral surface of the genital segment below and in front of the bases of the egg strings. It is made up of a single small joint. The anal laminae are thick and fleshy, much longer than the abdomen itself, and they taper to a blunt point. They are entirely destitute of setae and spines.

The first antennae are rather long, seven-jointed, thickest through the tip of the third joint, and thence tapering gradually. Below and behind the basal joint of each antenna, and filling the marginal notch in the carapace, is a thick triangular process or palp. When the antenna is folded back against the carapace this process is nearly concealed, but it stands out prominently if the antenna be turned forward at right angles to the body axis. The joints of these antennae are only sparingly supplied with setae. The second antennae are transformed into strong attachment organs. They are three-jointed, the basal joint much swollen, the second joint narrowed distally and armed on the ventral surface with a stout peg so placed as to interlock with the tip of the terminal claw. The latter is short and is bent into a half circle.

The upper and under lips are fused and produced into a long, stout and bluntly rounded mouth tube. At its base on either side are

the first maxillae, which are slender, conical, about three-fourths as long as the mouth tube, each tipped with two long setae. The palp is short, conical, and tipped with two spines of unequal length.

The second maxillae are peculiar; the two basal joints are much swollen and rather short; the third joint is abruptly narrowed to half the width of the second, but is much longer. It is enlarged and almost squarely truncated at the distal end, produced into a conical process on the outer margin, and surrounded with a fringe of short spines. The fourth joint is hemispherical and is attached to the inner margin of the tip of the third joint. The flat side is turned outward and is surrounded with a fringe of short spines.

The maxillipeds are large, very stout, and furnished with a powerful terminal claw. There are three pairs of swimming legs, each transformed into a broad and thin lamella, covered with numerous minute transparent dots. Each leg of the two anterior pairs is notched on the inner margin, but does not show any rami; the margin of the third legs is entire.

Color.—Carapace dark brown at the center, paler and yellowish toward the edges; dorsal elytra and foliaceous legs gray-white, covered with minute transparent spots; free thorax, genital segment, and abdomen dark yellowish brown.

Total length, 10–15 mm.; carapace, 9.50 mm. long, 7 mm. wide; combined diameter of foliaceous legs, 10–11 mm.; egg strings, 40–50 mm. long.

Specific characters of male.—While the male resembles the female in size and general appearance, it also differs in several important particulars. The carapace is relatively longer and narrower and is similarly notched at the center of the posterior margin. The antennal area is only half as long as wide. There are no dorsal elytra on the fourth segment, so that the entire body behind the carapace is visible in dorsal view, but is covered ventrally as in the female by the foliaceous legs.

Each leg of the first two pairs is notched on the inner margin and carries in the notch a pair of distinct, though rudimentary, one-jointed rami. The appendages are practically the same as those of the female, the second antennae and maxillipeds being a little larger.

Color the same as that of the female, but appearing darker because of the absence of the dorsal elytra.

Total length, 8–10 mm. Carapace, 6 mm. long, 4.15 mm. wide. Combined diameter of foliaceous legs, 4 mm.

Remarks.—This shark parasite is very widely distributed and has been found upon several other kinds of sharks besides those here mentioned. It never occurs in any numbers on a host, but is more often solitary, although occasionally the two sexes are associated upon the same fish. Its favorite location is in the throat of the shark,

attached to one of the gill arches. In addition to the fact already noted that the imbricated foliaceous laminae enclosing the posterior body of the female and covering the sides and ventral surface of the male are found in no other copepod; the color of these laminae is also peculiar. The grayish-white background is thickly sprinkled with minute circular dots and irregular lines, which, being transparent, appear darker in color.

The species has been described and figured many times, but the female has thus far succeeded in absorbing all the attention and no figure of the male has appeared. The foliaceous legs of the male are of peculiar interest by reason of the presence of rudimentary rami upon the first two pairs, which do not appear in the female (figs. 7 and 8).

Genus NORION Nordmann.

Norion Nordmann, Bull. Soc. Imp. des Nat. Moscou, vol. 37, 1864, p. 488.
Norion Bassett-Smith, Proc. Zool. Soc. London, 1899, p. 469.

Generic characters of female.—General body form an ellipsoid, flattened dorsoventrally, both surfaces covered with subconvex shields. Head fused with the first thorax segment and the two distinctly separated from the rest of the body by a short neck; the remaining thorax segments fused inter se; no abdomen. Dorsal carapace divided into anterior and posterior portions by deep lateral incisions, the anterior part projecting forward as a narrow, pointed wing on either side of the cephalothorax, the posterior part evenly rounded. Ventral carapace divided into right and left halves, anteriorly by the cephalothorax, posteriorly by a deep median incision, each half with a median longitudinal keel.

First antennae filiform, six-jointed; second antennae with a swollen basal joint and a powerful, curved terminal claw; first maxillae two-jointed, apparently setiferous; second maxillae and maxillipeds also two-jointed but uncinate. A pair of rudimentary first legs at the posterior margin of the cephalothorax, mere curved pads without rami.

Type of the genus.—*Norion expansus*, monotypic.

Remarks.—This genus was established by Nordmann upon a single female specimen taken from the inside of the gill cover of an unknown fish at Honolulu. He located the genus in the family Chondracanthidae near the genus *Tucca.* No investigator besides Nordmann has ever seen this genus, and none except Bassett-Smith has ever mentioned it. He recognized that it was not a Chondracanthid, and placed it in the present family, but he still retained Nordmann's idea that it was closely related to *Tucca*, and so he transferred that genus to the Dichelesthiidae along with *Norion.* The two genera, however, have nothing in common; in volume 39 of these proceedings

(p. 352) *Tucca* was shown to be an Ergasilid, and *Norion* is just as certainly a Dichelesthiid.

Nordmann did not find any traces of the swimming legs, but the curved pads on the posterior margin of the cephalothorax are quite manifestly the rudiments of the first pair of legs, and it is also possible, as Basset-Smith has suggested, that the divided ventral plate may represent the remaining legs, but he was certainly wrong when he stated that the anterior wing-like expansions belonged to the ventral plate and that there were no dorsal plates.

A revised diagnosis is here presented in order to call attention again to this remarkable parasite and to offer certain corrections and suggestions in reference to its morphology.

The genus seems valid and corresponds well with *Anthosoma*, *Caetrodes*, and *Sagum*. Accordingly we may accept it as far as it has been described and await further information before finally deciding upon its validity.

Genus CAETRODES Wilson.

Caetrodes WILSON, Report on the Pearl Oyster Fisheries of the Gulf of Manaar, by W. A. Herdman, Supplementary Report No. 34, pt. 5, p. 203.

Generic characters of female.—Body regions distinct. Head covered with a dorsal carapace, which is obovate in shape, strongly arched and considerably widened anteriorly, narrowed and flattened posteriorly, where it projects back over the thorax segments but is not attached to them. Frontal margin turned under the carapace, carrying the base of the anterior antennae onto the ventral surface. Five free thorax segments, indistinctly separated and diminishing in width backwards, the fifth one sending back a wide lobe on either side of the genital segment. The latter small, transversely oblong and inclosed on three sides by the fifth segment. Abdomen small, hemispherical, one-jointed; anal laminae longer than the abdomen, narrow, and terminating in a spine and a claw.

First antennae five-jointed, slender, sparsely setose; second pair stout, ending in a prehensile claw. First and second maxillae rudimentary, uniramose, two-jointed, attached close beside the mouth tube and about the same size. Maxillipeds slender, two-jointed. Two pairs of biramose swimming legs close together at the anterior end of the thorax; rami linear, two-jointed. Egg tubes longer than the body, eggs large, not much flattened. Male unknown.

Type of the genus.—*Caetrodes pholas*, monotypic.

Remarks.—This genus is at once distinguished by the claws on the tips of the anal laminae, which assist the parasite in maintaining its peculiar hold upon its host. So far as known no other copepod is thus armed.

Genus SAGUM Wilson.

Sagum WILSON, Proc. U. S. Nat. Mus., vol. 44, 1913, p. 234.
Lernanthropus (part) KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 196.

Generic characters of female.—General body form similar to that of *Lernanthropus*, but somewhat shorter and stouter. Cephalothorax angular; antennal area separated from the rest of the head by deep marginal sinuses; lateral margins produced into an angular wing on either side; posterior body covered with a dorsal plate which is prolonged at the posterior corners of the third thorax segment into lobes, and which is more or less fused along the median line with the dorsal plate of the fourth segment. Antennae and mouth parts similar to those of *Lernanthropus;* first and second swimming legs much reduced, with one-jointed rami; third legs flattened into laminae which cover the ventral surface and reach back to the posterior margin of the body; fourth legs also flattened into laminae reaching the posterior margin, the tips of the rami ending in long flagella. Fifth and genital segments and abdomen reduced and concealed. Egg strings coiled into the space between the dorsal plate and the third and fourth legs and thus entirely concealed.

Generic characters of male.—Body divided into two sections, cephalothorax and posterior body, each covered with a dorsal plate, the two about the same size. Antennal area separated as in the female. First antennae seven-jointed and prominent; second antennae and mouth parts like those of the female. First and second swimming legs rudimentary; third pair with a single ramus in the form of a long cylindrical flagellum; fourth legs like those of the female, each ramus consisting of a basal lamina and a terminal flagellum, the exopod with an accessory flagellum. Genital segment and abdomen not covered, but visible in dorsal view.

Type of the genus.—*Sagum flagellatum* Wilson, monotypic.

KEY TO THE SPECIES.

Posterior processes at the corners of the third segment broad and extending diagonally outward away from the following segments, reaching the posterior margin of the dorsal plate ________________ *flagellatum* Wilson, 1913.
Posterior processes narrow and pointed, and closely appressed to the sides of the following segments, reaching only halfway to the posterior margin of the dorsal plate ____________________________ *angulatum* (Krøyer), 1863, p. 28.

SAGUM ANGULATUM (Krøyer).

Lernanthropus angulatus KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 196, pl. 9, fig. 1 *a–q*.

Specific characters of female.—General form short and stout; cephalothorax one-fourth of the entire length, its length and width in the proportion of 5 to 7, with an invagination on either side ante-

riorly, and a pointed angle at the center where the lateral margin is drawn backward. The anterior margin projects between the invaginations as a rounded rostrum, less than one-seventh of the length of the cephalothorax. Free thorax segments fused and covered with a single dorsal plate, which on the midline is the same length as the head. This plate does not project at the anterior corners, but is prolonged at the posterior corners into pointed processes, as long as the plate itself and closely appressed to the sides of the posterior body. This latter is covered with a dorsal plate as wide as long, which is somewhat invaginated at the center of the posterior margin. The fifth and genital segments and abdomen are entirely concealed between the third and fourth legs and this dorsal plate.

The egg strings are long and are coiled in this same space between the legs and the dorsal plate, and thus out of sight.

First antennae six-jointed, the first joint the largest, the last one the smallest, all well armed with setae. Second antennae with a stout and strongly curved basal joint and a short but strong terminal claw. First maxillae simple, three-jointed and tipped with a small seta; second maxillae and maxillipeds with stout basal joints and small terminal claws.

First swimming legs consisting of a short, rounded process tipped with three protuberances, the outer one lance-shaped, the middle one circular, the inner one ovate, tipped with a stout seta; second legs similar. Third legs biramose, the rami flattened into laminae, the outer ramus longer than the inner, the fold between the two projecting from ventral surface. Fourth legs each made up of two stout, broadly oval, slightly curved laminae, the outer one the larger, each ending in a flagellum. Abdomen smaller than the genital segment, much wider than long; anal laminae twice the length of the abdomen, regularly tapered, five-jointed, first joint much the largest.

Specific characters of male.—To the generic characters already noted we may add the following: General form an elongated oval, the cephalo-thorax a little wider than the posterior body. Antennal area projecting as in the female. First antennae twice the size of those in the female. Second antennae joined at the base across the midline by a chitin knob. Second maxillae and maxillipeds relatively larger than in the female, but otherwise the same. First and second swimming legs proportionally larger, but made up similarly of a basal process and three protuberances; third and fourth legs as already given.

Total length of female, 4.50 mm.; greatest width, 1.80 mm. Total length of male, 1.35 mm.; greatest width, 0.54 mm.

Remarks.—This species was originally described by Krøyer from several specimens, including both sexes, obtained from the gills of an undetermined species of West Indian *Serranus*. All other ac-

counts are copies of Krøyer's original and no one else has seen the species. The description given above is taken partly from Krøyer's text and partly from his figures, with such changes in his nomenclature as would make his statements intelligible. If this description be compared with that of *Sagum flagellatum*, given by the present author in volume 44 of these Proceedings (p. 235), it will be clearly seen that Krøyer's species belongs to the present genus and not to *Lernanthropus* where he placed it.

Heller, in his Reise der *Novara*, 1865, in a footnote on page 213 relative to the genus *Lernanthropus*, said:

> Krøyer's genus *Aethon* is closely related to *Lernanthropus*, if not identical with it. Although Krøyer does not mention it in his latest work on the parasitic copepods, it is very evident to me that the new species, *Lernanthropus angulatus*, there described and figured by him, is identical with his *Aethon quadratus*, previously described. And this is the more likely because both were found upon a West Indian *Serranus* species.

A comparison of these two species described by Krøyer makes Heller's suggestion seem extremely improbable, and for the following reasons: In *Aethon* the cephalothorax is three-fourths as wide as the posterior body, from which it is separated by a distinct neck; the dorsal plate covering the posterior body is as wide as the free thorax; the first antennae are small and insignificant; the third swimming legs are close together on the median line, are only one-eighth the length of the posterior body, and are folded like those of *Lernanthropus*, projecting obliquely from the ventral surface.

In the present species, which is the second one described by Krøyer, the cephalothorax is as wide as the posterior body; there is no neck; the dorsal plate covering the posterior body is as wide as the free thorax; the first antennae are large and prominent; the third legs are flattened into laminae, which are as long as the posterior body, and cover its entire ventral surface. Krøyer said nothing about the fourth legs in *Aethon*, and presumably they did not possess the peculiar flagella which he noted in the present species. Such differences preclude Heller's suggestion of the identity of the two species. The genus *Aethon* probably becomes a synonym of *Lernanthropus*, but retains its own specific name, and hence becomes *Lernanthropus quadratus*.

Genus LERNANTHROPUS Blainville.

Lernanthropus BLAINVILLE, Journ. de Physique, de Chimie, d'Hist. Nat., vol. 95, 1822, p. 444.

Epachthes NORDMANN, Mikrographische Beiträge, 1832, pt. 2, p. 45.

Lernanthropus BURMEISTER, Act. Acad. Caes. Leop. Carol. Nat. Cur., vol. 17, 1833, p. 303.

Aethon KRØYER, Naturhistorisk Tidsskrift, ser. 1, vol. 1, p. 257, pl. 2, fig. 9, 1837.

Lernanthropus STEENSTRUP and LÜTKEN, Kong. Danske Videns. Selsk. Skrifter, ser. 5, vol. 5, 1861, p. 395.

Lernanthropus KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 193.

Lernanthropus NORDMANN, Bull. Soc. Imp. des Nat. Moscou, vol. 37, 1864, p. 499.

Stalagmus NORDMANN, Bull. Soc. Imp. des Nat. Moscou, vol. 1864, p. 510.

Lernanthropus HELLER, Reise der *Novara*, 1865, p. 221.

Lernanthropus HEIDER, Arbeit. Zoolog. Inst. Wien, vol. 2, pt. 3, 1879, p. 269.

Lernanthropus GOGGIO, Atti Soc. Toscani Sci. Nat. Pisa, vol. 22, 1906, p. 134.

Lernanthropus BRIAN, Copepodi parassiti dei Pesci d'Italia, 1906, p. 63.

Lernanthropus T. and A. SCOTT, British Parasitic Copepoda, 1912, p. 110.

External generic characters of female.—Head fused with first thorax segment, the resulting cephalothorax oblong or pyriform, with a dorsal carapace whose lateral margins are curved over ventrally. Free thorax segments fused and covered with a dorsal plate, which is prolonged backwards over the genital segment and abdomen. The latter small and one-jointed. First antennae filiform, the joints more or less fused. Second antennae prehensile, uncinate. Mandibles stylet-shaped, toothed on the inner markin. First maxillae palp like; second maxillae and maxillipeds prehensile, uncinate. First two pairs of swimming legs rudimentary, biramose, the rami one-jointed: rami of third and fourth pairs transformed into broad lamellae. Each lamella of the third pair represents a fused exopod and endopod, projects at right angles or diagonally from the ventral surface and is folded along its midline, so that its cross-section is in the form of a half circle. There are usually four lamellae in the fourth legs, and they extend backward. Egg strings elongate, eggs uniseriate and strongly flattened.

External generic characters of male.—Cephalothorax separated from the free thorax and covered with a carapace whose lateral margins are flat. Free thorax fused with the genital segment and without a dorsal plate. Abdomen one-jointed and wholly visible in dorsal view. Second antennae prehensile and relatively larger than in the female. Third and fourth swimming legs, with the rami transformed into thread-like filaments.

Internal generic characters.—The usual digestive canal running straight through the entire body. Sex organs paired, the ovaries lying over the digestive canal in the second thorax segment, the testes similarly placed in the posterior part of the cephalothorax; sex ducts much convoluted. Cement glands club shaped, extending along the lateral margins of the dorsal surface and reaching forward to the posterior end of the ovaries. Semen receptacle also club shaped under the intestine at the posterior end of the genital seg-

ment. Spermatophore receptacle large and near the posterior end of the genital segment.

The distinguishing character of the genus is a closed vascular system made up of two ventral longitudinal trunks running under and close to the intestine, one on either side, and a single dorsal trunk over the intestine and between the paired sex organs. From these central trunks branches lead to the various appendages and there is also a network of capillaries over the dorsal surface and in the laminate swimming legs. No part of the system has any connection with the lumen of the body cavity. The trunks and capillaries are filled with a yellowish-red liquid, which streams back and forth under the influence of the peristaltic movements of the digestive canal, and aided by the contraction of the muscles of the various appendages and body regions. This liquid contains neither blood corpuscles nor any other definite constituents, and hence can not be called true blood, but it probably serves as an oxygen carrier between the body regions and into the appendages.

Type of the genus.—*Lernathropus musca* Blainville, 1822, monotypic.

KEY TO THE SPECIES.

(The number preceding the species name represents the total length of that sex and species.)

1. A dorsal plate covering the free thorax and genital segment, but leaving the abdomen visible in dorsal view ---- 12
1. A dorsal plate covering the entire body, leaving nothing visible except the rami of the third and fourth legs ---- 2
1. No dorsal plate, the free thorax, the genital segment and the abdomen entirely visible in dorsal view ---- 30
2. Third legs folded in the usual manner and projecting at right angles or obliquely to the ventral surface ---- 3
2. Third legs flattened into broad laminae parallel with the ventral surface and covering nearly the whole of it ---- 24
2. Third legs narrow laminae, uniramose or divided and lying flat on the ventral surface, but covering only a little of it ---- 27
3. Dorsal plate all one piece, with no transverse groove or marginal sinuses -- 4
3. Dorsal plate divided into an anterior and posterior portion by a transverse groove or by marginal sinuses ---- 8
4. Males, dorsal plate no wider than the cephalothorax; third and fourth legs projecting well beyond its margin ---- 5
4. Females, dorsal plate but little wider than the cephalothorax, and about the same diameter throughout ---- 6
4. Females, dorsal plate widened posteriorly to twice the diameter of the cephalothorax ---- 7
5. Cephalothorax longer than dorsal plate; latter obovate, much narrowed posteriorly ---- 1 mm., male, *larvatus* Heller, 1865
5. Dorsal plate much longer than cephalothorax, not narrowed, but squarely truncated posteriorly ---- 1.50 mm., male, *lativentris* Heller, 1865
5. Cephalothorax and dorsal plate about the same length, the latter broadly rounded posteriorly ---- 1.50 mm., male, *holmbergii* Nordmann, 1864

6. Fourth legs projecting but little beyond the dorsal plate; rami slender and cylindrical__________________________3 mm., female, *vorax* Richiardi, 1880
6. Fourth legs projecting their entire length; rami flattened into lanceolate laminae______________________________4.50 mm., female, *mugilis* Brian, 1898
6. Fourth legs projecting their entire length; rami slender, cylindrical; dorsal plate divided by a deep longitudinal incision like the wings of a fly,
8 mm., female, *musca* Blainville, 1822
7. Posterior margin of dorsal plate smoothly rounded; fourth legs not reaching this margin____________________________female, *polynemi* Richiardi, 1881
7. Posterior margin of dorsal plate smoothly rounded; fourth legs project well beyond this margin________________2.25 mm., female, *belones* Krøyer, 1863
7. Posterior margin of dorsal plate deeply bilobed, the sinus triangular and reaching center of plate______________3 mm., female, *trachuri* Brian, 1903
8. Posterior portion of dorsal plate the same width as the anterior portion or narrower____9
8. Posterior portion of dorsal plate distinctly wider than the anterior portion_19
9. Anterior portion of dorsal plate with large lateral wings; fourth legs projecting nearly their entire length,
3.30 mm., female, *caudatus*, new species, p. 37
9. Anterior portion of dorsal plate with large lateral wings; fourth legs not projecting at all____10
9. Anterior portion of dorsal plate without wings, but with processes at its posterior corners; fourth legs projecting more or less__________________11
9. Anterior portion of dorsal plate without wings or processes; fourth legs projecting moderately____12
10. Genital segment short and wide, without transverse folds; fourth legs cut to center, rami slender and acuminate,
2.50 mm., female, *trigonocephalus* Heller, 1865
10. Genital segment narrow and elongate, with transverse folds; fourth legs cut to their base, rami broad laminae bluntly pointed, the exopod slightly the longer__________________________2.75 mm., female, *pagelli* Krøyer, 1863
10. Genital segment narrow and elongate, with transverse folds; fourth legs cut to their base, rami broad laminae, bluntly pointed, the endopod much the longer________________________2.25 mm., female, *scribae* Krøyer, 1863, p. 46
11. Fourth legs short, projecting half their length, rami subparallel; no fifth legs____________________________________3 mm., female, *atrox* Heller, 1865
11. Fourth legs elongate, cylindrical, projecting three-quarters of their length, rami divergent; fifth legs present; processes on anterior dorsal plate flaring,
9 mm., female, *giganteus* Krøyer, 1863
11. Fourth legs not projecting at all; no fifth legs; processes closely appressed to the body_________________3.37 mm., female, *quadratus* (Krøyer), 1837
12. Abdomen wholly or partially visible in dorsal view; fourth legs visible their entire length____13
12. Abdomen wholly covered by the dorsal plate; fourth legs only partly visible, their bases being covered____16
13. Rami of fourth legs longer than the entire body and acuminate_________14
13. Rami of fourth legs much shorter than the entire body and acute________15
14. Anterior portion of dorsal plate overlapping the posterior portion and bilobed; cephalothorax also invaginate at the center of the posterior margin,
5 mm., female, *nudus* Basset-Smith, 1898
14. Anterior portion of dorsal plate neither overlapping nor bilobed; cephalothorax not invaginate but with its lateral margins curled far over ventrally,
7.60 mm., female, *tenuis*, new name, p. 38

15. Dorsal plate invaginate posteriorly; third legs of the usual pattern; fifth legs present__________________3.15 mm., female, *rathbuni*, new species, p. 39
15. Dorsal plate evenly rounded posteriorly; third legs enlarged at their tips; no fifth legs____________________2.50 mm., female, *leidyi*, new species, p. 40
16. Tips of anal laminae almost or quite reaching posterior margin of dorsal plate; fourth legs projecting nearly their entire length__________________17
16. Tips of anal laminae considerably in front of posterior margin of dorsal plate; fourth legs projecting half their length or less____________________18
17. First antennae rudimentary; cephalothorax much narrower than free thorax; third legs parallel_________________female, *brevis* Richiardi, 1886
17. First antennae three-jointed; cephalothorax as wide as free thorax and notched on either side__________________5 mm., female, *nobilis* Heller, 1865
17. First antennae five-jointed; cephalothorax much narrower than free thorax; third legs divergent__________5 mm., female, *gisleri* P. J. van Beneden, 1852
17. First antennae eight-jointed; cephalothorax much narrower than free thorax; third legs parallel—7 mm., female, *pomatomi* R. Rathbun, 1887, p. 42
18. First antennae rudimentary; cephalothorax much narrowed anteriorly; third legs parallel; fourth legs narrow, acuminate laminae, with the tips only projecting_________4 mm., female, *koenigii* Steenstrup and Lütken, 1861
18. First antennae three-jointed; cephalothorax slightly narrowed anteriorly; third legs parallel; fourth legs broad laminae, bluntly rounded, projecting their whole length_________5 mm., female, *brevoortiae* R. Rathbun, 1887, p. 43
18. First antennae rudimentary; cephalothorax with a horn-like process at each anterior corner; third legs parallel; fourth legs with acuminate laminae__________________________4.75 mm., female, *spiculatus* Wilson, 1913
18. First antennae prominent, six-jointed; cephalothorax widened anteriorly; third legs widely divergent; fourth legs narrow blunt laminae, not projecting at all________________8 mm., female, *trifoliatus* Bassett-Smith, 1898
19. Dorsal plate not covering fourth legs; no posterior sinus; body only twice as long as wide or less____20
19. Dorsal plate covering fourth legs and wrapped around ventrally like the skirts of a cloak____23
20. Rami of fourth legs slender, cylindrical, and acuminate; anal laminae only reaching the center of the dorsal plate__________________________________21
20. Rami of fourth legs broad laminae; anal laminae almost or quite reaching the posterior margin of the dorsal plate_______________________________22
21. Cephalothorax with a long conical process projecting laterally from each posterior corner____________________7 mm. female, *tylosuri* Richiardi, 1880
21. Cephalothorax ovate with smoothly rounded margins; no processes; free thorax wider than long_____________2.25 mm., female, *pagodus* Krøyer, 1863
22. Rami of fourth legs projecting nearly their entire length, with filiform tips______________________________5.50 mm., female, *foliaceus* Richiardi, 1880
22. Rami of fourth legs projecting only half their length; bluntly pointed, not divided to their base_________________5 mm., female, *krøyeri* Beneden, 1851
22. Rami of fourth legs projecting only half their length; bluntly rounded, armed with spiny processes_________6 mm., female, *lappaceus* Wilson, 1912
23. Dorsal plate in dorsal view shaped like an hourglass; cephalothorax one-third the entire length______3 mm., female, *chlamydotus*, new species, p. 48
23. Dorsal plate with straight lateral margins; cephalothorax only one-sixth the entire length__________9.50 mm., female, *paenulatus*, new species, p. 51
24. Dorsal plate entirely covering the fourth legs; third legs broad laminae with bluntly rounded tips____25
24. Fourth legs projecting more or less; third legs narrower laminae with pointed tips; fifth legs present_____________________________________26

25. Third legs covering the genital segment, the abdomen, and nearly all of the fourth legs; cephalothorax wider than long; free thorax with projections at anterior corners-------------3 mm., female, *larvatus* Heller, 1865
25. Third legs covering only bases of genital segment and fourth legs, the rest free; cephalothorax much longer than wide; free thorax without projections--------------------------------3 mm., female, *lativentris* Heller, 1865
25. Third legs covering entire ventral surface; cephalothorax wider than long, lobed on the lateral margins; free thorax with processes at anterior and posterior corners----------------------5 mm., female, *percis* Thomson, 1889
26. Cephalothorax narrowed anteriorly; dorsal plate with a shallow posterior sinus------------------------------3.50 mm., female, *frondeus* Wilson, 1913
26. Cephalothorax widened anteriorly; dorsal plate with a deep median posterior sinus------------------------2 mm., female, *obscurus* Wilson, 1913
27. A plate on the ventral surface similar to the dorsal plate and covering the bases of the third and fourth legs--------------------------------------28
27. No ventral plate; the third and fourth legs, the genital segment, and the abdomen entirely visible in ventral view---------------------------------29
28. Posterior margin of dorsal plate deeply bilobed; the genital segment and abdomen entirely concealed---4.50 mm., female, *temminckii* Nordmann, 1864
28. Posterior margin of dorsal plate pointed; the genital segment and abdomen visible ventrally--------------10 mm., female, *petersi*, Beneden, 1857, p. 36
29. Fourth legs projecting their entire length; their rami the same diameter throughout and squarely truncated at their tips; third legs uniramose,
5 mm., female, *nordmanni*, new name, p. 47
29. Fourth legs projecting their entire length, their rami acuminate; third legs biramose, rami acute-------8.70 mm., female, *paradoxus* (Nordmann), 1832
29. Fourth legs not reaching posterior margin of dorsal plate; cephalothorax with a deep incision on either side near the anterior margin,
6 mm., female, *pupa* Burmeister, 1833
30. Fourth legs undivided and broadly foliaceous----------------------------31
30. Fourth legs undivided and cylindrical------------------------------------32
30. Fourth legs divided half their length or less----------------------------33
30. Fourth legs divided to their base---------------------------------------36
31. Fourth legs pointed at their tips and unarmed; third legs narrow and cylindrical-----------------------------1.85 mm., male, *pagelli* Krøyer, 1863
31. Fourth legs broadly rounded at their tips and armed with spiny processes,
2 mm., male, *lappaceus* Wilson, 1913
31. Fourth legs emarginate at their tips, leaving two knobs armed with short spines--------------------------2 mm., male, *chlamydotus*, new species, p. 48
32. Cephalothorax narrowed and rounded anteriorly; fourth legs slender, bluntly rounded, and nearly as long as the entire body; third legs much shorter--------------------------------2 mm., male, *obscurus* Wilson, 1913
32. Cephalothorax narrowed and rounded anteriorly; fourth legs stout and acute at the tips and much shorter than the body; third legs one-third as long as the fourth---------------2 mm., male, *pomatomi* Rathbun, 1887
32. Cephalothorax broad and squarely truncated anteriorly; fourth legs stout, bluntly rounded, much shorter than the body; third legs mere stumps, very short--------------------------1 mm., male, *leidyi*, new species, p. 40
33. Cephalothorax narrower and shorter, than the free thorax---------------34
33 Cephalothorax wider and longer than the free thorax---------------------35
34. Rami of fourth legs broad and bluntly pointed; endopod of third legs much shorter than exopod-------------------3 mm., male, *krøyeri* Beneden, 1851
34. Rami of fourth legs narrow and acuminate; rami of third legs subequal,
3 mm., male, *gisleri* Beneden, 1852

34. Rami of fourth legs broad but ending in a narrow tapering point; endopod only half the length of the exopod; endopod of third legs also very short.
2.50 mm., male, *paenulatus*, new species, p. 51
35. Third and fourth legs widely divergent; third pair uniramose; rami of fourth pair equal_____________1.50 mm., male, *trigonocephalus* Heller, 1865
35. Third and fourth legs biramose, the endopods much shorter than the exopods_______________2 mm., male, *koenigii* Steenstrup and Lütken, 1861
36. Third legs undivided, slender and pointed________________________________37
36. Third legs divided to their base_____________________________________38
36. Third legs divided half their length, endopod much shorter than the exopod________________________________male, *micropterygis* Richiardi, 1882
36. Third legs with a tiny rudimentary endopod near the base of the exopod,
2.75 mm., male, *giganteus* Krøyer, 1863
37. Rami of fourth legs equal; third legs nearly as long as the fourth pair,
5 mm., male, *nudus* Bassett-Smith, 1898
37. Endopod of fourth legs much shorter than exopod; third legs shorter than endopod of fourth pair____________3.50 mm., male, *frondeus* Wilson, 1913
38. Third legs as long as fourth pair; anal laminae linear, ten times as long as wide__________________________________3 mm., male, *atrox* Heller, 1865
38. Third legs only half the length of the fourth pair; anal laminae four times as long as wide_______________________2 mm., male, *vorax* Richiardi, 1880
38. Third legs only half the length of the fourth pair; anal laminae as wide as long______________________________________male, *brevis* Richiardi, 1880

Synonyms.—Nordmann described a new genus and species under the name *Epachthes paradoxus* in his Mikrographische Beiträge, 1832, part 2 (p. 45). In the text on pages 46 and 47 he gave references to plate 12, figures 12, 13, and 14, but no such plate was published with his paper, and the only illustration that has ever appeared is a single figure published by Burmeister in 1833. He claimed that the species belonged in the genus *Lernanthropus* on account of its resemblance to *Lernanthropus pupa*, and this claim was afterwards acknowledged as correct by Nordmann himself. Accordingly the species *paradoxus* has been included in the key just given.

In the same paper in which Nordmann acknowledged Burmeister's claim [19] he endeavored to establish upon Beneden's *Lernanthropus petersi* a new genus, which he proposed to call *Stalagmus*. The validity of this genus has been denied by most authors, and apparently with good reason. Although it differs in many particulars from other species these differences do not seem to warrant generic distinction.

Again in this same paper Nordmann described (p. 508) and figured (pl. 7, figs. 5–8) some specimens which he referred to Beneden's species *krøyeri*, but which are certainly distinct, and hence they have been given the new name *nordmanni*.

In his discussion of this genus [20] Goggio established a new species which he named *lichiae*, but the following year he acknowledged it as a synonym of Brian's *trachuri*.

[19] Bull. Soc. Imp. Nat. Moscou, vol. 37, 1864, p. 510.
[20] Atti Soc. Tosana Sci. Nat., Pisa, vol. 22, 1906, p. 144.

Richiardi[21] gave a brief description, without figures, of a new species of *Lernanthropus*, which he named *micropterygis*. Goggio in the paper just referred to (1906) claimed to recognize Richiardi's species, and gave figures of male and female adults. He also claimed that Brian's species *thompsoni*[22] was a synonym of *micropterygis*.

Brian himself in his Copepodi Parassiti dei Pesci d'Italia, 1906 (p. 66), made *thompsoni* a synonym of *gisleri*, but later published an error slip stating that this was a mistake and that it should be a synonym of *micropterygis*. In this same paper (p. 65) Brian claimed that Heider's species "*krøyeri, var.*" was a synonym of Richiardi's *brevis*, but Goggio, in the Pisa paper already referred to, identified *brevis* very differently and gave good figures of both sexes. If his interpretation is correct then Heider's name must be retained and does not become a synonym.

Heider, Valle, and Brian have each stated that probably the species described by Heller as *trigonocephalus* is identical with the one established by Krøyer as *scribae*. Heller frankly acknowledged that the two species had many similarities, but contended that they differed enough to warrant keeping them separate.

LERNANTHROPUS CAUDATUS, new species.

Plate 1, figs. 9–11; plate 2, figs. 12–15.

Host and record of specimens.—Three adult females were obtained from the gills of the sheepshead, *Archosargus probatocephalus*, at Beaufort, North Carolina, July 25, 1905. The best specimen was selected as the type of the species with Cat. No. 54061, U.S.N.M.; the other two become paratypes with Cat. No. 54062, U.S.N.M.

Specific characters of female.—General form short and thickset; cephalothorax narrowed anteriorly, swollen posteriorly, the lateral lobes produced considerably in front of the central margin. Anterior portion of dorsal plate produced into a large lateral lobe on either side, which curves over ventrally, leaving prominent rounded corners both anteriorly and posteriorly. Posterior portion of plate nearly a circle in outline, its margin evenly and smoothly rounded.

First antennae indistinctly six-jointed, not visible except in a ventral view. Second antennae of the usual pattern, the stout terminal claw strongly curved. Mouth tube rather small; maxillae also small and weak; second maxillae large and powerful; maxillipeds with a stout terminal claw nearly as long as the basal joint and jointed once near the center. First legs small and hidden beneath the maxillipeds, the endopod a conical knob tipped with a single long spine, the exopod flattened into a lamina, tipped with five short

[21] Processi verbali Soc. Toscana Sci. Nat., Pisa, vol. 4, 1885, p. 82.
[22] Atti. Soc. Ligustica Sci. Nat., vol. 9, 1898, p. 17, pl. 3, fig. 16.

and stout spines. Second legs with the basipod much swollen, almost spherical, but with the rami much smaller than those of the first pair. The exopod is flattened, circular in outline, and armed with several minute spines arranged irregularly. The endopod is boot shaped and apparently unarmed. The third legs are exceptionally long and narrow; the fourth pair are divided to their bases and project nearly their entire length behind the dorsal plate. Their rami are flattened into thin laminae, which are widest in the center and taper toward either end. The anal laminae are long and narrow-lanceolate, their tips reach a little beyond the posterior margin of the dorsal plate. None of the females carried egg strings.

Color a uniform yellowish gray.

Total length, not including fourth legs, 3.30 mm. Width of anterior portion of dorsal plate, 2 mm. Length of four legs, 2.85 mm.

(*caudatus*, long-tailed.)

Remarks.—The distinguishing characters of this species are the large lateral wings on the anterior portion of the dorsal plate and the broad rami of the fourth legs which project nearly their entire length. The females of *trigonocephalus*, *pagelli*, and *scribae* also have large lateral wings, but their fourth legs either do not reach the posterior margin of the dorsal plate, or barely pass it. The plate in *trigonocephalus* is so narrowed posteriorly that the fourth legs sometimes project beyond its lateral margins, but they hardly pass the posterior margin, and they are only cut to their center, while here the rami are separated to their very base. The boot shape of the endopod of the second legs is also peculiar and unlike that of any other species.

These parasites are not at all common, since many sheepsheads were examined during the summer, but only these three specimens were obtained. The side view shown in figure 12 gives the best idea of the lateral lobes of the anterior thorax and also of the exceptional length of the third legs.

LERNANTHROPUS TENUIS, new name.

Lernanthropus, species BRIAN, Atti Soc. Ligustica Sci. Nat., vol. 9, 1898, p. 19, pl. 3, fig. 14.

Remarks.—In the reference above given Brian described a species of parasitic copepod which he referred to the present genus, but to which he gave no specific name. In going over the described species for the purpose of making the key which appears above it was found that this species did not belong with any hitherto described. Accordingly the above name is suggested for it.

(*tenuis*, slender, thin.)

LERNANTHROPUS RATHBUNI, new species.

Plate 2, figs. 16–19; plate 3, figs. 20–22.

Host and record of specimens.—Two females were obtained from the gills of a hogfish, *Orthopristis chrysopterus*, at Beaufort, North Carolina, July 24, 1905. They are made types of the new species with Cat. No. 54069, U.S.N.M.

Specific characters of female.—Cephalothorax subquadrangular, as wide as the body, with broad lateral flaps, each of which projects in a rounded lobe forwards and backwards. The sinus between the lobe and the antennal area anteriorly is narrow and deep; that between the lobe and the thorax posteriorly is broad and shallow. Anterior and posterior portions of the dorsal plate about the same length and width, with a broad sinus on either margin between them. The anterior portion is gradually narrowed anteriorly to meet the cephalothorax, without any lateral prominences or shoulders. The posterior portion is obovate, strongly narrowed posteriorly, with a broad sinus at the tip, through which can be seen the anal laminae and a portion of the abdomen. The genital segment is much wider than long and projects in a half circle on either side. The abdomen is only half as wide as the genital segment and is two-jointed, the joints of the same length and width.

The anal laminae are broad ovate, flattened dorsoventrally, and attenuate at their tips. The egg strings are attached to the sides of the genital segment; they are the same width as the rami of the fourth legs and a little longer than the entire body.

The first antennae are attached considerably behind the frontal margin; they are quite distinctly segmented, with seven joints. The second antennae are of the usual pattern, a swollen basal joint and a strong terminal claw. The second maxillae have a fairly stout basal joint and a long and slender claw, which is bent into a half circle near its tip, the basal portion being straight. Proximal to the curve on the inner margin is a small tooth, between which and the tip are two rows of minute teeth, one along each side of the inner margin.

The maxillipeds are large and strong, the base of the claw being considerably reinforced, but the claw itself is curved only a little.

The first legs have a broad flattened exopod tipped with four large spines and a fifth, much smaller one at the distal end of the outer margin.

The endopod is conical and ends in a single long slender spine; the inner margin bears distally a row of minute teeth. Inside the endopod is a single large spine. The second legs have oblong flattened rami, the exopod tipped with a long spine, the endopod with three spines of about the same size at the tip and two much smaller ones on the inner margin. Inside the endopod is a small rounded knob. The

third legs are of the usual pattern, well separated and standing out at right angles to the ventral surface. The fourth legs are divided nearly to their base; the rami are cylindrical, slender, and taper to a rather fine point; they are about two-thirds as long as the body. A pair of fifth legs is present in the form of short tapering rami, one on either side of the fifth segment, in front of the genital segment.

Color (preserved material) yellowish brown.

Total length, 3.15 mm. Cephalothorax, 1 mm. long, 1 mm. wide. Greatest width of body, 1.15 mm. Length of fourth legs, 2 mm.; of egg strings, 4 mm.

(*rathbuni*, to Richard Rathbun, who did much excellent work on the parasitic copepods.)

Remarks.—The distinguishing characters of this new species are the position of the first antennae, removed some distance from the frontal margin, the deep and narrow sinus on either side of the antennal area, the reentrant sinus at the tip of the dorsal plate, the presence of a fifth pair of legs, and the details of the various appendages.

The species can not be very common, for after these two specimens were obtained a large number of hogfish were examined without finding any more of the parasites.

LERNANTHROPUS LEIDYI, new species.

Plate 3, figs. 23–27; plate 4, figs. 28–30.

Host and record of specimens.—Forty females were obtained from the gills of the white perch, *Morone americana*, at Beaufort, North Carolina, July 12, 1905. One of these has been selected as the type of the species with Cat. No. 53572, U.S.N.M. The others become paratypes with Cat. No. 53573, U.S.N.M. A second lot of 50 females was obtained from the gills of the yellowtail, *Bairdiella chrysura*, July 20, 1905, also at Beaufort; these have been given Cat. No. 53574, U.S.N.M. A third lot was obtained from the same host at Beaufort by Dr. Edwin Linton September 19, 1902. This lot contained a single male and 30 females and has been given Cat. No. 53575, U.S.N.M., the male being isolated and placed in a separate vial.

Specific characters of female.—General body form oblong, about twice as long as wide, with the fourth legs projecting their entire length. Cephalothorax subquadrangular in dorsal view, slightly narrowed anteriorly, the lateral margins curled over ventrally a long distance. A narrow antennal area is separated at the anterior margin, to the sides of which are attached the first antennae. Anterior portion of dorsal plate much wider than posterior in young females and somewhat wider in mature adults, with a deep sinus on each lateral margin at the junction of the two portions. Posterior portion narrowed and shortened in young females, leaving both the

genital segment and the abdomen exposed in dorsal view. In mature adults it is lengthened and broadly rounded, leaving only the anal laminae visible dorsally.

Genital segment twice as wide as long, with protruding, convex lateral margins. Abdomen only half the width of the genital segment, narrowed anteriorly and with convex sides. Anal laminae cylindrical, filiform, five times as long as wide, with bluntly rounded tips, without setae.

First antennae small and indistinctly segmented, apparently about seven-jointed, somewhat flattened antero-posteriorly and regularly tapered, with two tiny setae at the tip. Second antennae on the ventral surface of the lateral flaps of the cephalothorax, consisting of a stout basal joint and a curved terminal claw. First maxillae at the sides of the mouth tube and very small; second pair long and slender, with a short terminal claw, having a row of saw teeth along each lateral margin. On the side of the terminal joint below the base of the claw is a small spine. The maxillipeds, like the second antennae, are made up of a stout basal joint and a curved terminal claw, apparently jointed near the center.

The exopod of the first legs is quadrangular, with five stout triangular spines along the terminal margin; the endopod is narrowed to a thin neck where it joins the basal joint, with a single long and slender spine at the inner distal corner. There is also a small spine on the ventral surface of the basal joint just above the endopod.

The third legs stand out at right angles to the ventral surface, with their tips considerably enlarged, as shown in figure 29.

Each fourth leg is divided to its base; the rami are slender, taper to a blunt point, and project practically their entire length behind the dorsal plate. The egg strings are considerably thicker than the rami of the fourth legs, and about as long as the body and legs together.

Color (preserved material), a uniform yellowish brown.

Total length of body, 2.50 mm.; of cephalothorax, 0.75 mm. Width of cephalothorax, 0.65 mm.; of anterior body, 1.15 mm.; of posterior body, 1 mm. Length of fourth legs, 1.85 mm.; of egg strings, 3.85 mm.

Specific characters of male.—Cephalothorax exceptionally large, wider than the body and about half the entire length, the posterior margin widened and bilobed, the anterior margin narrowed and squarely truncated. Body narrowed where it joins the cephalothorax, widened through the bases of the first and second legs and in the genital segment.

First antennae more distinctly seven-jointed than in the female; second antennae and maxillipeds relatively larger and stouter. First and second swimming legs like those of the female; third legs reduced to minute uniramose stumps, easily overlooked. Fourth legs unira-

mose, three-fourths as long as the whole body, rather stout and bluntly rounded at the tips. Anal laminae slender and filiform, four times as long as wide, each tipped with two tiny setae.

Color (preserved material), a uniform yellowish brown.

Total length, 1 mm. Cephalothorax 0.40 mm. long, 0.35 mm. wide. Fourth legs, 0.72 mm. long.

(*leidyi*, to Dr. Joseph Leidy, one of the early American pioneers in the study of the Crustacea.)

Remarks.—This new species is especially distinguished in the female by the long and slender fourth legs and by the shortness of the dorsal plate, which shows the anal laminae and sometimes a portion of the abdomen. In the male the best mark of recognition is the large squarely truncated cephalothorax and the greatly reduced third legs. The latter scarcely show in dorsal view and are so reduced as to be easily overlooked. The species is fairly common, and many specimens can often be obtained from a single fish.

LERNANTHROPUS POMATOMI Rathbun.

Lernanthropus pomatomi R. Rathbun, Proc. U. S. Nat. Mus., vol. 10, 1887, p. 567, pls. 33–35.—M. J. Rathbun, Occasional Papers, Boston Soc. Nat. Hist., vol. 7, 1905, p. 98.

Mr. Richard Rathbun established this species in 1887 for more than one hundred specimens taken from the gills of bluefish *Pomatomus saltatrix* Linnaeus, caught in Vineyard Sound in 1883 and 1885. He published a complete description of both sexes, accompanied by excellent figures, in the reference given above.

A few specimens were found at Beaufort, North Carolina, by the present author in 1905, and from one of the females, whose eggs were just ready to hatch, many nauplii were secured. These were examined at the time and differed considerably from the one in figure 57.

The following is a list of the specimens at present in the collection of the United States National Museum, including those obtained by Rathbun:

Cat. No.	Specimens.	Locality.
6026	30 females	Vineyard Sound, Massachusetts.
6027	2 males	Do.
6050	20 females	Do.
6051	2 males	Do.
6056	15 females	Do.
6156	25 females	Do.
12684	8 females, 1 male	Do.
54065	20 females	Woods Hole, Massachusetts.
54066	10 females, 1 male	Beaufort, North Carolina.
54067	2 females, 5 males	Woods Hole, Massachusetts.
54068	7 females	Do.

Specific characters of nauplius.—General form ovate, nearly twice as long as wide, widest through the bases of the third appendages, narrowed posteriorly, with evenly curved lateral margins. Appendages long and slender. Eye double and situated so far forward as to touch the anterior margin. Balancers close to the posterior end of the body, long and slender, with a slight S curve, extending outward nearly at right angles to the body axis. On each lateral margin in front of the base of the balancer is a small but distinct notch.

General color brown, the food mass in the posterior portion of the body and the central digestive tract a very dark brown, the margins of the body and the muscles connected with the appendages much lighter in color, the appendages themselves and the balancers a light gray.

Total length, 0.35 mm. Greatest width, 0.19 mm.

Remarks.—This nauplius may be distinguished from that of *brevoortiae* by the length and narrowness of the body, by the greater relative length of the appendages, and by the presence of eyes, or rather of a compound eye, on the anterior margin. The color is also quite different in the two nauplii, especially by transmitted light.

LERNANTHROPUS BREVOORTIAE Rathbun.

Plate 7, figs. 51–55, 57; plate 8, figs. 58–60; plate 10, fig. 75.

Lernanthropus brevoortiae R. RATHBUN, Proc. U. S. Nat. Mus., vol 10, 1887, p. 563, pl. 30, figs. 7 and 8, pls. 31 and 32.—M. J. RATHBUN, Occasional Papers, Boston Soc. Nat. Hist., vol. 7, 1905, p. 97.

Host and record of specimens.—Mr. Richard Rathbun obtained about 50 specimens, all females, from the gills of menhaden, *Brevoortia tyrannus*, captured in Vineyard Sound in 1883 and 1885. The following specimens have been added to the Museum collection since his paper was published, all from the same host: Six females captured at Woods Hole, Massachusetts, September 3, 1904, with Cat. No. 54052, U.S.N.M.; 35 females, most of them very small, and a single male from the gills of several young fish only 4 inches long at Beaufort, North Carolina, August 10, 1905, with Cat. No. 54054, U.S.N.M.; 15 females, some of which are still fastened to the gill filaments, taken at Woods Hole, Massachusetts, August 6, 1901, with Cat. No. 54053, U.S.N.M.; 10 females taken July 20, 1905, at Woods Hole, Massachusetts, with Cat. No. 54056, U.S.N.M.; 2 females taken July 20, 1905, at Beaufort, North Carolina, with Cat. No. 54055, U.S.N.M. These records, with those of Rathbun, show that the species is quite common along our Atlantic coast, but thus far only a single male has been obtained, and yet diligent search for males was made at Woods Hole during the entire summor of 1903 and at Beaufort during 1905. Finally a school of very young menhaden

were captured in the pound net at Beaufort, and upon one of them, only 2 inches in length, were found two young female parasites of the present species and one male. This extreme inequality of the sexes is the more remarkable in view of the fact that other species of this same genus, obtained from fish caught at the same time, were about evenly divided. From these facts we may infer that the males of some species can be found only upon fish which are quite immature, and even the youngest fish are not to be overlooked as sources of desirable specimens.

Specific characters of male.—General body form short and stocky; cephalothorax as wide and almost as long as the body, with smoothly convex margins, the antennal area projecting anteriorly. Eye double and distinctly visible about one-third the distance from the anterior margin, just behind the antennal area. Body obovate, one-fifth longer than wide, bluntly pointed posteriorly. Genital segment considerably narrower than the free thorax, but long and containing large spermatophore receptacles. Abdomen much narrower than the genital segment; anal laminae short and very narrow.

First antennae like those of the female; second pair enlarged, with a very stout basal joint and a curved terminal claw. The bases of the basal joints are fused on the midline; on the inner margin above the fusion is a pointed process or peg against which the tip of the claw shuts when closed. Each mandible has a slender basal portion and an enlarged tip, which is toothed along its inner margin, the margins of the two mandibles being parallel. The first maxillae extend outward on either side from about the center of the base of the proboscis and at right angles to its long axis. Each consists of a small joint next to the proboscis, corresponding to the chewing blade and armed with a single stout spine, and a larger swollen joint, outside of the chewing blade, covered with hairs and tipped with two spines of unequal size.

The second maxillae are removed some distance behind the proboscis; their basal joint is moderately swollen, their terminal joint is long and slender, and is tipped with a short conical claw. The tip of the terminal joint and the outer margin of the claw are armed with minute spines.

The maxillipeds consist of a very stout basal joint furnished with powerful muscles, and a large terminal claw bent into a half circle.

The first swimming legs are seen in figure 55 and are almost exactly like those of the female, the only difference being that here the two rami are about the same size, while in the female the exopod is much larger than the endopod. The third and fourth legs are uniramose, thick cylinders bluntly rounded at their tips, the third pair about half the length of the fourth, and the latter one-fourth longer than the body behind the cephalothorax.

Color (preserved material) a uniform yellowish brown.

Total length, 1 mm. Width of cephalothorax, 0.45 mm.; of body, 0.40 mm.

Specific characters of nauplius.—Body of medium size and elliptical in outline, the posterior end somewhat pointed, the width about two-thirds of the length. Of the appendages the first antennae are the stoutest and are armed with the longest plumose setae. The second antennae and mandibles are rather slender, but carry the usual number of setae, four on the endopod and two on the exopod. The balancers are long and slender and are slightly enlarged at the base; the terminal portion is bent like the bowl of a spoon. They are carried well forward almost at right angles to the long axis of the body. In the egg strings these nauplii appear cinnamon brown by reflected light, but when examined by transmitted light the pigment changes to a dark olive green. This pigment occupies the whole center of the body and is arranged in the shape of a shield, the anterior end narrowed and convexly truncated, with small prominent corners, the posterior end bluntly pointed. Outside of this pigment mass is a strip of transparent mesenchyme, whitish or grayish in color, very narrow posteriorly, wider and denser anteriorly. Outside of the mesenchyme is a narrow clear margin, formed by the fusion of the dorsal and ventral portions of the cuticle.

The muscles which move the appendages are quite distinctly shown, especially through the mesenchyme.

Total length, 0.33 mm. Greatest width, 0.25 mm.

Vascular system.—Looked at from the dorsal surface we find a single central, longitudinal trunk, considerably enlarged in the cephalothorax and free thorax, and tapering gradually posteriorly. In the center of the cephalothorax is a pocket or receptable, out of which leads posteriorly the enlarged longitudinal trunk, and anteriorly a short branch to each anterior corner of the head; there is also a short branch from the center of either side of the pocket. The longitudinal trunk gives off two branches near the posterior margin of the cephalothorax on either side, a single branch at the center of the free thorax, and a large branch in the genital segment leading to each fourth leg. In the carapace and the two portions of the dorsal plate, and in the laminae of the fourth legs these branches anastomose into a network of fine tubes which covers the entire surface. Within these tubes the vascular liquid is freely exposed to oxygenation. On the ventral surface we find two longitudinal trunks which give off branches to the various appendages.

At the anterior end are two branches which ramify towards the side lappets of the cephalothorax, in which there is often a profuse network of capillaries. Then follow branches to the second antennae, the second maxillae, the maxillipeds, and the swinging legs. The capil-

lary network in the third and fourth legs is especially profuse and fully equals that found on the dorsal surface.

The figures here given (figs. 59 and 60) of the vascular system were made in 1905 from living specimens. Heider called attention to the fact that this vascular system can not be recognized in specimens preserved in the ordinary way. And even in those which have been treated by the most approved methods it is usually unrecognizable, or at least it can not be traced in any detail.

LERNANTHROPUS CARANGIS Hesse.

Lernanthropus caranxi HESSE, Revue des Sciences Naturelles, vol. 7, 1878, p. 8 (reprint), pl. 1, figs. 1–7.

Lernanthropus carangis BASSETT-SMITH, Proceedings Zool. Soc. London, 1899, p. 470.

Lernanthropus carangis GOGGIO, Atti Soc. Toscana Sci. Nat. Pisa, vol. 22, 1906, p. 138.

Remarks.—This species was referred by its author to the present genus, and was so accepted by the two investigators named above. There are, however, several serious differences which must be adjusted before the species can be definitely located. The head is described and figured as distinctly separated from the thorax; the segments of the thorax are fused and carry at their anterior end three pairs of biramose legs, each consisting of a basal joint which covers half the width of the thorax, and two tiny one-jointed rami, armed with six or seven small spines. The posterior portion of the dorsal plate is split down the center for its entire length and the lateral margin of each half at its anterior end curves around the side of the body and is continuous with the lateral margin of a ventral plate which extends beyond the tips of the anal laminae. The fourth thorax segment is three times as thick dorsoventrally as the fifth, and is crescent-shaped in side view, with the points turned backward. Such a creature manifestly can not belong to the genus *Lernanthropus*, nor indeed to any of the other accepted genera, and yet its antennae and mouth parts, the first two and the fourth pair of legs, and the color are just like those of the present genus.

In view of these discrepancies and because no two of Hesse's figures agree in their details or correspond with his text, and further because only a single specimen has ever been found we are compelled to reject the species from the present genus, but are unable to locate it anywhere else.

LERNANTHROPUS SCRIBAE Krøyer.

Lernanthropus scribae KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 203, pl. 9, fig. 3 *a–g*.

Lernanthropus scribae HEIDER, Arbeiten Zool. Inst. Wien, vol. 2, 1879, p. 354.

Remarks.—It was suggested by Heider and has been repeated by other authors that this species described by Krøyer and the one des-

ignated as *trigonocephalus* by Heller in 1865 are identical. If this be true, then Krøyer's name takes precedence and must be retained, while Heller's becomes a synonym. But the identity of the two species does not seem possible, owing to the following differences:

1. The lateral margins of the head are smoothly convex in *trigonocephalus*, while they are sinuate with deep invaginations in *scribae*.
2. The wings on the free thorax project forward at the anterior corners and backward at the posterior corners in *scribae* and are simply rounded, without projecting, in *trigonocephalus*.
3. The posterior portion of the dorsal plate is strongly narrowed anteriorly and posteriorly in *trigonocephalus*, while it is nearly the same width throughout in *scribae*.
4. The genital segment, abdomen, and anal laminae are without transverse grooves in *trigonocephalus;* such grooves are present in *scribae* and give the genital segment the appearance of being made up of three joints, while each anal lamina appears also three-jointed.
5. The fourth legs in *trigonocephalus* are divided less than half their length, the rami are narrow, acuminate and equal, while they project laterally half their length beyond the dorsal plate. In *scribae* the legs are divided almost to their base, the endopod is considerably longer and wider than the exopod and both are bluntly rounded, while they do not reach the margin of the dorsal plate but are wholly covered in dorsal view.

Such marked differences seem to preclude the idea of the identity of the two species, and accordingly they have been kept separate.

LERNANTHROPUS NORDMANNI, new name.

Lernanthropus krøyeri NORDMANN, Bull. Soc. Imp. Moscou, vol. 37, 1864, p. 508; pl. 7, figs. 5–8.

Remarks.—P. J. van Beneden described and figured [23] a new species of *Lernanthropus*, to which he gave the name *krøyeri*. The species was afterward noted by Claus, who added a description and figures of the male. It has been subsequently mentioned by nearly every investigator who has worked in the Mediterranean, and finally both sexes were again described and figured by A. Scott,[24] this time from British seas. Meanwhile Nordmann, in the reference given above, described and figured three female specimens, which he identified as belonging to this species and which were taken from the gills of a large *Labrax lupus* on the coast of Normandy. A comparison of Nordmann's description and figures with those of Beneden and Scott shows that the species are not the same. The differences which separate them are the following:

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[23] Ann. des Sci. Nat., ser. 3, vol. 16, 1851, p. 102, pl. 3, figs. 7–9.

[24] Trans. Biol. Soc. Liverpool, vol. 21, 1907, p. 95, pl. 3, figs. 1–13.

1. The length of the female figured by Scott was 21.70 mm., including the fourth legs, that by Claus was 12.50 mm. without the fourth legs, while Nordmann's species was only 7 mm. without the fourth legs.

2. The cephalothorax in *krøyeri* is trapezoidal in outline, the antennal area is separated from the rest of the head, with a large lobe on either side at its base. The two diameters of the head are in the proportion of 5 for length and 6 for breadth. In *nordmanni* the cephalothorax is triangular, pointed anteriorly, with sinuate sides, the antennal area is not separated, and the two diameters are equal.

3. The anterior portion of the dorsal plate in *krøyeri* is wider than long, the two diameters in the proportion of 4 to 3; in *nordmanni* it is longer than wide, in the proportion of 6 to 5.

4. In *krøyeri* the posterior margin of the dorsal plate is an evenly rounded half circle, in *nordmanni* it is squarely truncated, leaving sharp corners and a sinuate margin.

5. In *krøyeri* the dorsal plate entirely covers the genital segment, the abdomen, and the basal half of the fourth legs, its margin reaching well beyond the tips of the anal laminae. In *nordmanni* the abdomen is entirely, and the genital segment is partially, visible in dorsal view, and the fourth legs project nearly their whole length.

6. In *krøyeri* the fourth legs are widest at the center and taper toward both ends, the tips being acute. In *nordmanni* the fourth legs are of uniform width throughout with squarely truncated tips.

Such an accumulation of differences shows that Nordmann was dealing with a distinct species, and the name *nordmanni* is suggested for it.

(*nordmanni*, to Prof. Alexander V. Nordmann, who first described the species.)

LERNANTHROPUS CHLAMYDOTUS, new species.

Plate 4, figs. 31–35; plate 5, figs. 36–39; plate 6, fig. 40; plate 13, fig. 104.

Host and record of specimens.—Seven males and 16 females were taken by Dr. Edwin Linton from the gills of the silver gar, *Tylosurus marinus*, at Beaufort, North Carolina, September 1, 1902. A single female has been isolated and made the type of the new species, with Cat. No. 54063, U.S.N.M. The remaining specimens of both sexes become paratypes, with Cat. No. 54064, U.S.N.M.

Specific characters of female.—General shape short and thickset; cephalothorax half as long as the body, narrowed anteriorly, but widened across the posterior margin until it equals or slightly exceeds the anterior margin. The anterior end is inclined downwards and forwards and its lateral flaps are so long they protrude far in front of the ventral surface. This gives it an appearance very similar to the old-fashioned poke bonnet. Body with the shape of an hour-

glass, the dorsal plate all one piece, entirely covering the third and fourth legs and wrapped around ventrally like the skirts of a military cloak flaring outward.

Genital segment about as long as wide, its lateral margins not very convex; abdomen half the width of the genital segment, much narrowed anteriorly, widened through the posterior margin. Anal laminae flattened dorsoventrally, the basal half of uniform width, the terminal half tapered to a blunt point tipped with two small spines. Egg strings wide, but not very long, projecting half their length behind the dorsal plate.

First antennae entirely concealed in dorsal and lateral views, attached just above the bases of the second pair and apparently four-jointed, the jointing being indistinct. The last joint is heavily armed with setae. Second antennae composed of a stout basal joint and a curved terminal claw. They also are entirely covered by the sides of the cephalothorax, and can be seen only when the side flaps are pushed back. The mouth tube is short and conical. The first maxillae have an almost spherical inner portion, armed posteriorly with a single large spine. The outer portion is much longer, tapers to a blunt point, and is armed with two unequal spines, the largest one posterior. The second maxillae have a stout basal joint and a nearly straight terminal claw, which is bluntly rounded at the tip, where it is armed with a row of fine teeth along either margin for a short distance.

The maxillipeds are large and stout, the basal joint much swollen, and the terminal claw sharply curved near the tip.

First and second swimming legs similar to those of the male, third pair folded in the usual manner and extended in front of the body parallel with each other and at right angles to the body axis. Fourth legs biramose, divided not quite to the base, the rami flattened dorsoventrally into broad, bluntly pointed laminae, of which the exopod is a little the longer. In young females the tips of these fourth legs project beyond the posterior margins of the dorsal plate, but in the fully developed adult the legs are entirely concealed.

Color (preserved material) a uniform yellowish brown.

Total length, 3 mm. Cephalothorax 1 mm. long, 0.85 mm. wide. Anterior portion of dorsal plate 0.80 mm. wide, posterior portion 1.50 mm. wide.

Specific characters of male.—General form short and thick set like the female; cephalothorax almost circular in dorsal outline, a trifle wider than long, with both pairs of antennae projecting from its anterior margin. Body as wide as the cephalothorax and about twice as long, the anterior corners evenly rounded. Genital segment relatively much longer than in the female, its sides fused with the bases of the fourth legs. Abdomen narrow, trapezoidal and short, the

anal laminae attached to its posterior corners and some distance apart.

First antennae four-jointed, attached not to the frontal margin but to the ventral surface in front of the bases of the second pair, which are like those of the female. The mouth tube and mouth parts are also like those of the female, the maxillipeds a trifle larger, and the terminal claw not as strongly bent.

The exopod of the first swimming legs is a flattened lamina, squarely truncated at the tip, and the terminal margin armed with a row of five broad saw teeth. The endopod is cylindrical, enlarged through the center, and terminates in a stout, hairy spine, twice as long as the joint itself. It also carries a row of small sharp spines along its inner margin. Between the endopod and the midline is a tiny process, coming out of the basal joint and unarmed.

The exopod of the second legs is also laminate, but the lamina is rolled into a loose cylinder. The terminal margin is squarely truncated and armed with a row of 12 to 15 soft spinous processes. The endopod is cylindrical and squarely truncated, with a row of small spines along the inner and terminal margins, the two at the outer distal corner being larger and wider than the others. On the ventral surface close to the terminal margin is a large smooth spine about as long as the endopod itself, and farther back beside the inner margin is a secondary row of small sharp spines. Outside the exopod is a jointed spine nearly as long as the exopod itself.

The third legs extend diagonally backward from the posterior corners of the third thorax segment and are about the same length as the fourth pair. They are uniramose, flattened laminae and end in a single rounded knob armed with small spines.

The fourth legs extend nearly straight backwards from the posterior corners of the fourth segment. They also are flattened laminae, somewhat widened through the center, and they end in two knobs armed with small spines. These knobs with a fairly deep sinus between them, and the general makeup of the appendages. indicate that each is really made up of two rami fused together.

Color (preserved material) a clear yellow, faintly tinged with brown.

Total length, including fourth legs, 2 mm. Cephalothorax 1 mm. long, 1.15 mm. wide. Length of fourth legs, 1.60 mm.

(*chlamydotus*, χλαμυδωτός, clothed with a cloak.)

Remarks.—The distinguishing character of this tiny species is its general appearance. It looks in side view like a little old woman enveloped in a voluminous skirt and wearing a large poke bonnet. The armature of the swimming legs is also peculiar, especially that of the exopod of the second pair.

LERNANTHROPUS PAENULATUS, new species.

Plate 6, figs. 41–48; plate 7, figs. 49–50, and 56.

Host and record of specimens.—Two females with egg strings were taken from the gills of the amber jack, *Seriola lalandi*, at Woods Hole, by Vinal N. Edwards. These have been given Cat. No. 54057, U.S.N.M., and become paratypes of the new species. A female with egg strings and a male were obtained from the same host September 11, 1901, by Dr. M. T. Thompson at Woods Hole. The female is made the type of the species with Cat. No. 54058, U.S.N.M. The male becomes an arsenotype with Cat. No. 54059, U.S.N.M. Another male was taken from the gills of the same host by Dr. Edwin Linton at Beaufort, North Carolina, September 23, 1902, and has been given Cat. No. 54060, U.S.N.M.

Specific characters of female.—General form elongate and narrow; cephalothorax a little longer than wide, with large lateral flaps which entirely cover and conceal the second antennae and mouth tube except in a ventral view. Anterior portion of dorsal plate twice as long as wide, with nearly straight lateral margins, the distance between the second and third swimming legs being exceptionally large. Posterior portion much widened, especially at the posterior margin, and wrapped around the fourth legs and egg strings, leaving only the tips of the fourth legs visible. Genital segment small, with strongly convex sides; abdomen minute, one-jointed; anal laminae narrow lanceolate, as long as the abdomen and genital segment together, but entirely concealed by the dorsal plate.

First antennae six-jointed, tapering, the setae scattered except on the terminal joint; second antennae with the usual swollen basal joint and stout terminal claw, attached close to the anterior margin of the head and covered by the side lappets of the cephalothorax.

Mouth tube conical, rather long and narrow; first maxillae triangular, the tip armed with two spines, the outer one much longer than the inner; there is also a short but stout spine on the inner margin one-third of the length from the base. Second maxillae with a long and rather slender terminal claw; maxillipeds stout, the claw strongly curved.

Exopod of first swimming legs flattened, squarely truncated and tipped with five short and blunt teeth; endopod of the usual form, conical and tipped with a large spine. Exopod of second legs somewhat boot-shaped, the "heel" on the outer margin at the base, the "toe" armed with four small spines. Endopod like that of the first legs. No secondary spine inside of the endopod.

Third legs opposite the center of the dorsal plate, turned ventrally at right angles to the body axis, not very long and not wide enough to meet on the midline, even at the base, but leaving a con-

siderable interval. A small accessory lobe on the outside of each leg at the base of the outer fold. Fourth legs divided to their base, the rami flattened and widest at the center; a pair of short fifth leg rudiments just in front of the genital segment. Egg strings longer than the whole body; eggs small and numerous.

Color (preserved material) a uniform brownish gray.

Total length, 9.50 mm. Width of anterior portion of dorsal plate, 1.75 mm.; of posterior portion, 3.50 mm. Length of egg strings, 16.75 mm.

Specific characters of male.—Cephalothorax subpyriform or elliptical, the anterior end somewhat narrowed, the proportion of the length to the width as 5 to 4. Second (first free) segment about the same width as the head; third segment widened through the bases of the third legs, which stand out almost at right angles to the body. Fourth, fifth, and genital segments fused, with the fourth legs extending backward and outward at an angle of about 45°. The spermatophore receptables are large and reach forward nearly to the center of the bases of the fourth legs.

First antennae six jointed; second pair relatively larger than in the female and appearing even larger still because they are not concealed at all. Mandibles slender, cylindrical, jointed once near the base, the tip flattened dorsoventrally and armed along the inner margin with a row of saw teeth. Maxillipeds a little larger than those of the female. First and second swimming legs as described for the female. Third legs biramose, the endopod much shorter than the exopod; fourth legs also biramose, the exopods flattened and much widened through the center, the endopods only half as long as the exopods and cylindrical.

Color (preserved material) a uniform yellowish gray.

Total length, 2.50 mm. Cephalothorax 1.25 mm. long, 1 mm. wide. Length of fourth legs, 1.50 mm.

(*paenulatus*, wearing the paenula or cloak.)

Remarks.—This species was determined to be new by the late Dr. M. T. Thompson, who had compiled a rough description of both sexes, accompanied by numerous pencil sketches, and had suggested the name which is given above. Two of his sketches are here published and the present author has borrowed freely from his notes.

The distinguishing characters of the species are the narrow body wrapped in its long cloak, the small and widely separated third legs, the visible tips of the fourth legs in the female, and the very short endopods of the third and fourth legs in the male. The female is long and narrow and thus the very opposite of *chlamydotus*, which is the only other species with the posterior portion of the dorsal plate enlarged and wrapped around the fourth legs and the egg strings.

Genus PENICULISA Wilson.

Peniculisa WILSON, Proc. U. S. Nat. Mus., vol. 53, 1917, p. 45.
Peniculus (part) KRØYER, Naturhistorisk Tidsskrift, ser. 3, vol. 2, 1863, p. 268.

External generic characters of female.—First thorax segment more or less distinctly separated from the head and with the second and third segments forming a sort of neck which is narrowed but not chitinized. Head elliptical, flattened, and covered with a dorsal carapace. Fourth, fifth, and genital segments fused, flattened, and covered with a dorsal plate. Posteriorly this fused trunk is prolonged into a wide flattened process on either side of the abdomen. The latter is small, one-jointed, and also prolonged into a flattened process at each posterior corner. Egg strings short and stout; eggs uniseriate and well flattened.

First antennae reduced to mere knobs; second pair much enlarged, uncinate, and prehensile; no maxillae; maxillipeds large, with strong claws.

Three pairs of rudimentary uniramose legs on the first three thorax segments; a fourth pair on the fused trunk some distance behind the anterior end.

Internal generic characters of female.—Esophagus inclined forward and entering the ventral surface of the stomach near the anterior end. Stomach narrowed into an intestine in the free thorax segments; intestine widened in the fused trunk and contracted into a short rectum in the abdomen. Ovaries dorsal to the intestine in the extreme anterior part of the fused trunk, oviducts much convoluted and occupying all the space dorsal and lateral to the intestine. Cement glands close together in the posterior portion of the fused trunk and ventral to the oviducts, the glandular portion an elongated ellipse, only reaching forward to the center of the trunk, the ducts very short. Semen receptacle on the floor of the trunk at the posterior end.

External generic characters of male.—General form similar to that of the female, but with differences in the body proportions. Posterior processes on the genital segment only a third as long as in the female, spatulate, strongly flattened at the tips. Abdomen without posterior processes, almost hemispherical in shape; anal laminae relatively larger and their setae longer. Antennae, mouth parts, and appendages similar to those of the female, except that the maxillipeds are larger and much stouter.

Type of the genus.—*Peniculisa furcata* (Krøyer), monotypic.

Remarks.—In these Proceedings (vol. 53, 1917, p. 45) certain reasons were presented for excluding the species *furcatus* from the genus *Peniculus*, where Krøyer had placed it, and establishing it as the

type of a new genus, which should belong to the family Dichelesthiidae rather than to the Lernaeidae. These reasons were based upon the external morphology, and it is gratifying to find that the internal structure gives added and convincing argument to the same end.

In the genus *Peniculus*, as in all the Lernaeidae, the ovaries are dorsal to the intestine at the anterior end of the second fourth of the fused trunk. The oviducts pass around the outside of the intestine to the ventral surface and thence straight back to the vulvae. There is not a convolution or the suggestion of one, and the eggs are pressed together so tightly that they are flattened into thin disks like a row of coins. In sharp contrast with this the oviducts in *furcatus* are convoluted back and forth until they fill the entire space, lateral and dorsal, between the intestine and the body wall. And the eggs inside of them remain spherical and are scattered about loosely without any definite arrangement. Accordingly we are justified in placing the new genus in the present family, to which it corresponds in all particulars, with the single exception of the posterior processes.

Genus KRØYERIA P. J. van Beneden.

Krøyeria Beneden, Bull. Acad. Roy. Belgique, vol. 20, 1853, p. 24.
Lonchidium Gerstaecker, Archiv für Naturg., vol. 20, 1854, pt. 2, p. 185; 1858, p. 24.
Krøyeria Claus, Ueber den Bau und die Entwickelung parasitischer Crustaceen. Cassel, 1858, p. 24.
Krøyeria Nordmann, Bull. Soc. Imp. des Nat. Moscou, vol. 37, 1864, p. 468.
Krøyeria Hesse, Ann. des Sci. Nat., ser. 6, Zool., vol. 8, 1879, p. 15, art. 29.
Lonchidium Bassett-Smith, Proc. Zool. Soc. London, 1899, p. 473.
Krøyeria Brian, Copepodi parassiti dei Pesci d'Italia, 1906, p. 67.
Krøyeria T. and A. Scott, British Parasitic Copepoda, 1912, p. 120.

Generic characters of female.—Cephalothorax broad, covered with a carapace having rounded lobes at its posterior corners. Inside each lobe on the posterior margin is a movable styliform process, projecting backward. Second, third, and fourth thorax segments free, each with a pair of swimming legs, but without lobes or dorsal plates. Fifth and genital segments completely fused, elongate, narrow cylindrical, with nearly straight lateral margins. Abdomen short; anal laminae long, narrow, and setose.

First antennae filiform, seven-jointed; second pair stout and chelate; mandibles and first maxillae small and rudimentary; second maxillae and maxillipeds large and armed with powerful claws. Four pairs of biramose swimming legs, each ramus three-jointed, setose. Egg strings linear, as long as the whole body; eggs thick and not strongly flattened.

Generic characters of male.—Cephalothorax relatively larger than in the female, but having similar posterior lobes and styliform processes. Second and third thorax segments sometimes enlarged, fifth and genital segments much shorter and narrower. Abdomen longer and distinctly three-jointed, anal laminae long and armed with plumose setae.

Antennae, mouth parts, and swimming legs like those of the female, the second antennae and maxillipeds being larger and stronger.

Type of the genus.—*Krøyeria lineata* P. J. van Beneden.

KEY TO THE SPECIES.

1. Abdomen of female containing but a single joint ---- 2
1. Abdomen of female two- or three-jointed ---- 3
2. Free thorax segments as wide as the genital segment; the latter four times as long as wide ---- *aculeata* (Gerstaecker), 1854
2. Free thorax segments much narrower than genital segment; the latter ten times as long as wide ---- *lineata* P. J. van Beneden, 1853
3. Genital segment the same width throughout its entire length; abdomen with but two joints ---- 4
3. Genital segment considerably widened posteriorly; abdomen three-jointed ---- 5
4. Cephalothorax nearly as wide as long; styliform appendages reaching center of fourth segment; anal laminae one-third the length of the abdomen, *scylli-caniculi* Hesse, 1878
4. Cephalothorax only half as wide as long; styloform appendages overlapping the genital segment; anal laminae two-thirds as long as the abdomen ---- *carchariae-glauci* Hesse, 1878
5. Styliform appendages reaching posterior margin of third thorax segment; abdomen longer than genital segment ---- *galei-vulgaris* Hesse, 1883
5. Styliform appendages only reaching posterior margin of second segment; genital segment four times as long as the abdomen. *acanthias-vulgaris* Hesse, 1878

Remarks.—This genus was established by Beneden in the reference given above and was placed in the family Caligidae, close to the genera *Trebius* and *Nogagus.* In the following year Gerstaecker described a closely allied parasite as a new genus and species, which he named *Lonchidium aculeatum.* In discussing its systematic affinities, although the structure of the swimming legs showed affinity with the Caligidae, Gerstaecker decided to place it with the Dichelesthiidae.

In 1899 Bassett-Smith made the two genera described by Beneden and Gerstaecker identical, but for some unknown reason adopted Gerstaecker's genus name and made Beneden's name a synonym. Brian in 1906 restored the name *Krøyeria* and was followed in this by T. and A. Scott in 1913. There is no doubt that their action is correct and that the name given by Beneden should be retained.

In the key given above the four species described by Hesse have been retained, and are separated according to the distinctive char-

acters stated in his text and portrayed in his drawings. By so doing, however, it must not be inferred that the present author is convinced of the validity of Hesse's species. As in all his work there are so many flat contradictions in both text and figures that his species can neither be accepted nor rejected with any certainty. Some future investigator must finally decide as to their truth or falsity. Meanwhile they seem to valid; and if so, may be distinguished as indicated.

Genus ERGASILINA P. J. van Beneden.

Ergasilina Beneden, Ann. Sci. Nat., ser. 3, vol. 16, p. 97, 1851.
Ergasilina Valle, Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 6, p. 67, 1880.
Ergasilina Stossich, Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 5, p. 263, 1880.

Generic characters of female.—General body form long and slender; head small and covered with a carapace; first and second thorax segments fused and separated from the head, bearing two pairs of legs; third and fourth segments free, each with a pair of legs; genital segment no larger than the fourth segment; abdomen one-jointed, strongly tapered; anal laminae lanceolate, without setae.

First antennae five-jointed, destitute of setae; second pair with two basal joints and a long and stout terminal claw. Maxillae three-jointed, the terminal joint a small claw or spine, the penultimate joint armed with minute teeth. Four pairs of swimming legs, uniramose, two-jointed, without setae, the terminal joint tipped with spines. Egg strings unknown.

Type of the genus.—*Ergasilina robusta* P. J. van Beneden, monotypic.

Remarks.—This genus was founded upon a single female obtained by Beneden from the gills of the common European ray, *Trigon pastinaca* Linnaeus. Ten years later, in his monogram, Recherches sur la Faune littorale de Belgique, Crustacés (p. 149), he reported that the genus was found regularly upon the gills of this fish. In another monograph published in 1870 on Les Poissons des Cotes de Belgique (p. 15) he recorded finding three specimens upon the same host, and a fourth much smaller one, which was possibly the male.

Beneden's original description and figures are the only ones ever published, and unfortunately they were quite imperfect. If, however, the statements and figures which he did give were correct, there can be no doubt of the validity of the genus. The fusion of the first and second thorax segments, the exceptional size of the second antennae, and the fact that all the swimming legs are uniramose and without setae fully establish the genus, but such peculiar characters make it all the more desirable that they should

be confirmed by subsequent examination. If the species is as common as its founder claimed, there is no reason why some one should not give a new and detailed description that would satisfy all queries.

It is worthy of note that Valle in his list of parasitic copepods found upon fish in the Adriatic Sea[25] mentioned this species of Beneden and enumerated five other fish hosts upon which it is common. One of these was another species of *Trygon*, two were skates belonging to Bonaparte's genus *Laeviraja*, and two were sharks of the genus *Mustelus*. Specimens from these hosts were deposited in the Civic Museum of Natural History at Trieste.

Bassett-Smith[26] made Beneden's *Ergasilina* a doubtful synonym of *Nemesis*, and Brian in 1906, Copepodi parassiti dei Pesci d'Italia (p. 72), followed his example. They also made another of Beneden's "new genera," *Pagodina*, a synonym of *Nemesis*. This last synonomy is undoubtedly correct (see p. 60), but if Beneden's figures and text are at all reliable *Ergasilina* can not possibly be identical with *Pagodina* and *Nemesis* and must constitute a new genus.

Unfortunately the same name, *Ergasilina*, was given by Burmeister in 1833 to the family of parasitic copepods which includes the genera *Ergasilus*, *Bomolochus*, and their relatives, and the name has been used in that sense by many subsequent writers. Valle in the paper above quoted even went so far as to call the first family of parasites Ergasilina, including *Bomolochus* and *Ergasilus*, and then placed Beneden's genus *Ergasilina* in an entirely different family, the Dichelestina. Such a confusion of family and generic names is greatly to be regretted, but according to the rules recently adopted in scientific naming both the family and the genus must be allowed to stand.

Genus CONGERICOLA P. J. van Beneden.

Not *Cycnus* HUBENER for a genus of Lepidoptera, 1816.
Cycnus MILNE EDWARDS, Histoire Naturelle de Crustacés, 1840, p. 495.
Not *Cycnus* HESSE, Ann. Sci. Nat., ser. 6, vol. 8, 1878, art. 11, p. 2.
Congericola BENEDEN, Bull. Acad. de Belgique, vol. 21, 1854, p. 583.
Congericola NORMAN, Ann. Mag. Nat. Hist., ser. 7, vol. 11, 1903, p. 369.
Congericola T. and A. SCOTT, British Parasitic Copepoda, 1912, p. 124.

Generic characters of female.—Head fused with first thorax segment to form a small, rounded cephalothorax, separated from the body by a neck composed of two narrow free thorax segments, without lobes or plates. Fourth segment wider than the second and third and more or less free. Fifth segment fused with the genital segment to form an elongate, subcylindrical body wider than the head and neck. Abdomen short, one-jointed; anal laminae cylindrical, setose.

[25] Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 6, 1880, p. 67.
[26] Proc. Zool. Soc. London, 1899, p. 476.

First antennae six-jointed; second pair two-jointed, short, uncinate. Maxillae minute, setose; maxillipeds elongate, slender, with small terminal claws. Egg tubes long, eggs flattened but little. Four pairs of biramose swimming legs; no fifth legs.

Generic characters of male.—Cephalothorax elliptical, wider than the rest of the body; second, third, and fourth thorax segments free; fifth segment fused with the genital segment, narrower than the free segments and short. Abdomen one-jointed; anal laminae much longer than the abdomen, narrow-cylindrical.

First antennae six-jointed; second pair very long, stout, and tipped with strong curved claws. Mouth parts and swimming legs like those of the female.

Type of the genus.—*Congericola pallida* P. J. van Beneden.

KEY TO THE SPECIES.

Two free segments the same width as the head; fourth legs much larger than the others, without setae .... *pallida* Beneden, 1854
Two free segments wider than the head; fourth legs smaller than the others, with setae .... *gracilis* (Milne Edwards), 1840

Remarks.—The name *Cycnus* was preoccupied by Hubener for a genus of Lepidoptera in 1816, and hence can not stand for a parasitic copepod genus, as was stated by Norman.[27] Hence Beneden's name must be adopted, and the type of the genus will be the species described by him.

Genus NEMESIS Risso.

Nemesis RISSO, Hist. Nat. des principales de l'Europe Meridionale, vol. 5, p. 135, 1826.
Nemesis ROUX, Crustacés de la Méditerranée, 1828, pl. 20, figs. 1–9.
Nemesis MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 486.
Pagodina BENEDEN, Bull. Acad. Roy. Belgique, vol. 20, 1853, p. 482.
Nemesis HELLER, Reise der *Novara*, Crustacea, 1865, p. 220.
Nemesis VALLE, Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 6, 1880, p. 66.
Nemesis BRIAN, Copepodi parassiti dei Pesci d'Italia, 1906, p. 71.

Generic characters of female.—Head fused with the first thorax segment, oval; four free quadrilateral thorax segments, each carrying a pair of biramose swimming legs, the first three as large as the cephalothorax or larger. Genital segment much smaller; abdomen narrower than the genital segment, two- or three-jointed; anal laminae minute and tipped with short spines.

First antennae ten- to fifteen-jointed, filiform, setose; second pair large, jointed, and ending in an exceptionally powerful claw. First maxillae minute, rudimentary; second pair two-jointed, terminating in a fleshy process. Maxillipeds very large, projecting their entire

[27] Ann. Mag. Nat. Hist., ser. 7, vol. 11, 1903, p. 369.

length beyond the carapace, and ending in a powerful sickle-shaped claw. First four pairs of legs biramose, rami two-jointed; fifth legs rudimentary, uniramose, two-jointed. Egg strings as long as the body, eggs thick and but little flattened.

Generic characters of male.—Body narrow and elongate. First thorax segment partially separated from the head; second, third, and fourth segments increasing in size; fifth segment smaller; genital segment smaller than the fifth segment; abdomen two-jointed; anal laminae narrow, elongate.

Basal joints of first antennae enlarged; second antennae small and weak. Maxillipeds modified into huge chelae, the dorsal jaw stout and bluntly rounded at the tip, the ventral jaw a long pointed claw. Fifth legs relatively much larger than in the female.

Type of the genus.—*Nemesis lamna* Risso, monotypic.

KEY TO THE SPECIES.

1. Cephalothorax triangular, widest at posterior margin, pointed anteriorly; first antennae six-jointed ____________ *carchariae-glauci* (Hesse), 1883, p. 60
1. Cephalothorax ovate, widest at anterior margin; fifth thorax segment as wide as the three preceding it ____________ *lamna* Risso, 1826
1. Cephalothorax ovate or elliptical, widest through the center; fifth segment half the width of the fourth or less; first antennae twelve- to fourteen-jointed ____________ 2
2. Cephalothorax nearly as wide as the second segment and smoothly rounded; posterior margin of fifth segment three-lobed; fifth legs one-jointed, without setae ____________ *atlantica*, new species, p. 60
2. Cephalothorax two-thirds as wide as the second segment, with a knob on each lateral margin in front of the center; posterior margin of fifth segment evenly rounded; fifth legs two-jointed ____________ *versicolor* Wilson, 1913
2. Cephalothorax less than half the width of the second segment, smoothly rounded; fifth segment also smoothly rounded; fifth legs one-jointed, with setae ____________ *robusta* (P. J. van Beneden), 1853

Remarks.—This genus was established in 1826 by Risso with the species *N. lamna*. Two years later Roux accepted Risso's name for some specimens which he had obtained from *Lamna cornubica* Linnaeus. But he tried to establish a new species, to which he gave the name *carchariarium*, upon other specimens taken from the gills of *Carcharias vulpes* Cuvier. In 1865 Heller, after examining Roux's type specimens in the Vienna Museum, concluded that the two species *lamna* and *carchariarum* were simply different development stages of the same copepod, but instead of giving Risso's name priority and making Roux's name a synonym he discarded both names and called the species *N. mediterranea*. This name accordingly becomes a second synonym of *lamna*, as indicated by Brian in 1906, although it had previously been adopted by Richiardi, Valle, Bassett-Smith, and even by Brian himself in 1898.[28]

[28] Atti. Soc. Ligustica Sci. Nat. e Georg., vol. 9, p. 15.

In 1853 Beneden[29] published a description of a parasitic copepod which he claimed as a new genus and named *Pagodina.* It is the same as Risso's genus and hence becomes a synonym of *Nemesis.*

NEMESIS CARCHARIAE-GLAUCI (Hesse).

Pagodina carchariae-glauci HESSE, Ann. Sci. Nat., Zool., vol. 16, 1883, p. 13, pl. 12, figs. 12–19.

Remarks.—The female of this species was described and figured by Hesse, and recorded as having been found on the gills of *Carcharias glaucus.* This is one of the hosts of *Nemesis robusta*, and that circumstance would suggest a careful comparison of the two species to make sure that Hesse was justified in separating them. Although such a comparison is difficult owing to the meagerness of the descriptions, at the same time it reveals so many radical differences that it does not seem possible for the two species to be identical.

The distinguishing characters of the present species appear to be the pointed anterior end of the cephalothorax and its squarely truncated and scalloped posterior margin; the slenderness of the second antennae and the weakness of their terminal claws; the fact that the abdomen is fully as wide as the genital segment and only two-jointed; the three-jointed exopods and two-jointed endopods of the swimming legs, according to Hesse's text. In figure 19, however, he portrays the first two pairs of legs; the first pair have three-jointed exopods and two-jointed endopods, as the text calls for, but in the second pair both rami are one-jointed. It would seem as if some of these differences must be real, and if so they would establish the validity of the species.

NEMESIS ATLANTICA, new species.

Plate 9, figs. 61–69; plate 10, figs. 70–74.

Host and record of specimens.—Thirty specimens, including both sexes, were taken from the gills of the sharp-nosed shark, *Scoliodon terrae-novae*, at Beaufort, North Carolina, July 26, 1905. A female with an attached male has been selected to serve as the type of the species, with Cat. No. 54051, U.S.N.M. The remaining specimens become paratypes with Cat. No. 32814, U.S.N.M.

Sixty specimens, including both sexes and development stages, were obtained by Dr. M. T. Thompson from the gills of the thresher shark, *Alopias vulpes*, at Woods Hole, July 20, 1902. The adult females, 30 in number, have been given Cat. No. 39564, U.S.N.M.; the males and young have been separated, with Cat. No. 39565, U.S.N.M. These specimens were especially numerous on the first pair of gills, the larger females with egg strings near the tips of the gill filaments, the males and undeveloped females nearer the bases.

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[29] Bull. Acad. Roy. Belgique, vol. 20, p. 482.

External specific characters of female.—Body elongate and quite thick-set, made up of a distinct cephalothorax, four free thorax segments, a genital segment, and three abdomen segments. Carapace elliptical, a little longer than wide, about one-fourth of the entire length, with an evenly curved outline. Its width in proportion to that of the second segment is as 6 to 7. Both pairs of antennae usually project from the anterior margin, while from the sides a pair of huge maxillipeds stretch back to the center of the second segment.

First three free segments about the same size, their length less than half their width. Each is entirely covered dorsally with a plate whose ends curve around the sides of the segment and reach a short distance onto the ventral surface. Each plate overlaps the one behind it like shingles on a roof, while the ends of all of them are free and stand out a little from the ventral surface. There is space enough between these ends for the thoracic legs to work freely. The posterior corners of the fourth segment are prolonged into short semicircular lobes, which project from beneath the posterior edge of the dorsal plate. The fifth segment is much narrower than the other three, obovate in shape, and considerably narrowed where it joins the fourth segment. The dorsal plate is the same shape as the segment, with a three-lobed posterior margin, the middle lobe being much wider than the lateral ones and overlapping the genital segment. This plate does not curve around the sides of the segment and hence is invisible from the ventral surface.

The genital segment is transversely elliptical, narrower than the fifth segment, with strongly convex sides. Posteriorly it is slightly emarginate, and this, with the overlapping median lobe of the fifth segment, gives it something of a dumb-bell shape in dorsal view.

The abdomen is about half the width of the genital segment and three-jointed, the first two joints very short, the terminal one much longer and hemispherical. The anal laminae are narrow, spindle-shaped, and longer than the last abdomen segment, with three short terminal setae, and a fourth still shorter one on the outer margin. Egg strings a little wider than the abdomen and not quite as long as the entire body, with 25 or 30 eggs in each string.

The first antennae have 10 or more joints, the divisions at the base being very indistinct. The second, the fourth, and the two terminal joints are longer than the others, which are all about equal. Every joint bears at least one seta on its anterior margin, the second joint has two with four others on its ventral surface, and the fourth joint also has two, with another one on its ventral surface. The last two joints are ellipsoidal, the terminal one tipped with five or six long setae.

The second antennae are four-jointed, the first and third joints about equal and considerably longer than the other two. The

terminal joint is shortest and consists of a short curved claw with a bifid tip, carrying on its inner margin a long accessory spine.

The mouth tube is in the shape of a truncated cone, a half longer than wide, and is too opaque to reveal the structure of its bony framework. The first maxillae lie so close to the base of the mouth tube that they are partially overlapped by its sides. Each consists of a conical base surmounted by two long spines, which reach to the tip of the mouth tube.

The second maxillae are two-jointed, the terminal joint the longer, club-shaped, and terminated with a wicked-looking array of spines. There is first at the inner distal corner a large claw curved outward and armed with five rows of stout and acuminate spines. A semicircular row of long stiff hairs starts from the inner corner of the base of this claw and curves around beckward onto the ventral surface. At the outer distal corner is a semicircular row of large, stout, and acuminate spines, which runs around the corner and then sweeps down onto the ventral surface at either end. This combination of stiff hairs and sharp spines must make a very effective arrangement for keeping the mouth parts clean.

The maxillipeds are the grasping organs and are very large and powerful; they are two-jointed, the joints about the same length and both strongly curved, the terminal one a simple claw.

All four pairs of legs are biramose, the rami of the first pair one-jointed, of the other three pairs two-jointed. The first legs are peculiar, the exopod being a broad, falcate, strongly flattened lamina curving around beneath the endopod. This is armed on its outer margin with short and sharp teeth and is tipped with a curved, blunt spine. The endopod is made up of three parts, all attached at the same level; the outer one is a broad but simple plumose seta, the other two are flattened laminae, covered with short hairs, the inner one elliptical in outline, its terminal margin armed with spines, the middle one triangular and tipped with a large curved spine. The exopod is capable of independent motion and the living copepod keeps shutting it past (underneath) the endopod like the blade of a pair of shears. The other three pairs of legs are alike, each consisting of a wide basal joint, with an oblique outer margin, to which is attached the exopod, while the larger endopod is jointed to the terminal margin. In both rami the joints diminish in size from the base outwards, and all are heavily armed with spines. On either side of the fifth joint in ventral view may be seen a small rudimentary leg, pointed backwards.

Color a bright clear yellow, nearly opaque; the digestive tract and egg strings a dark brown or even black, the legs almost white, the bases of the second antennae, the maxillae, and the maxillipeds

washed with a dull rust color. The entire maxillipeds are sometimes crimson, in which case they are not easy to distinguish against the background of the gill filament.

Total length, 5mm. Cephalothorax 1.40 mm. long, 1.35 mm. wide. Free thorax and genital segment 3.30 mm. long, the first three segments 1.90 mm. wide. Abdomen 0.70 mm. long. Egg strings 4.50 mm. long.

External specific characters of male.—General make-up as in the female, but with the body narrower and more elongate. Carapace one-fifth longer than wide and one-third of the length of the entire body, with a very regular elliptical outline. First free segment the same width as the carapace, the third and fourth segments diminishing slightly in size, the fifth segment nearly suppressed, appearing only as a short and narrow neck between the fourth and genital segments. But small as it is it has a pair of uniramose legs, which can be plainly seen in dorsal view. Genital segment relatively much larger than in the female; it is fully as wide as the free segments and two-thirds as long as the carapace, with strongly convex sides. It is covered dorsally and ventrally with two plates which fit closely to the skin. The dorsal plate is slightly emarginate at the center posteriorly, and only extends to the posterior margin of the spermatophore receptacles. The ventral plate is deeply emarginate beyond the center of the spermatophore receptacles, leaving the posterior portion of the latter uncovered. The posterior ventral portion of the segment itself is divided into two broad lobes slightly overlapping the abdomen and tipped with two spines. The sinus between these lobes is narrow and slitlike and extends forward nearly as far as the emargination of the ventral plate.

The spermatophore receptacles are simple, very large, almost perfectly elliptical in outline, and together fill nearly the entire segment.

The spermatophores are correspondingly large, spherical, and dark purple in color, and are often found attached to the genital segment of the female, as in figure 70. It will be seen that they are more than half the size of the genital segment of the female and that but a single spermatophore at a time could be contained in one of the male's receptacles. They swell somewhat also on contact with the sea water and are immediately surrounded with a layer of slime which makes them appear still larger. Their size and their deep purple color makes them conspicuous on the genital segment of the female.

The abdomen has four joints instead of three, diminishing regularly in width from in front backward. The two basal ones are longer than the two terminal ones and have convex sides; the penul-

timate joint is the shortest. The anal laminae are broad, longer than the last two abdomen segments together, and each tipped with three long plumose setae.

The appendages are like those of the female except that the mouth parts are more heavily armed with spines and setae, and in the swimming legs the short spines of the female are replaced by long plumose setae.

Color similar in all respects to that of the female.

Total length, 2.15 mm. Cephalothorax 0.86 mm. long, 0.65 mm. wide.

Internal specific characters of female.—Esophagus with a sharp bend near its center, opening into the ventral surface of the stomach a short distance back of its anterior end. Stomach considerably enlarged, but abruptly narrowed at the posterior margin of the cephalothorax. Intestine somewhat convoluted, extending through the center of the body, narrowed in the genital segment and then widened into a fairly long rectum.

Supraesophageal ganglion large and well defined; infraganglion a long spindle reaching back to the posterior margin of the cephalothorax. Ventral nerve running back to the fifth segment.

Ovaries above the stomach at the posterior end of the cephalothorax, each ovate and filled with genital protoplasm and egg filaments. The latter are divided transversely into separate cells, the eggs each with its own nucleus and nucleolus. These cells are separated as they pass into the oviduct and each develops into an egg. The oviduct opens out of the posterior end of the ovary and runs through the thorax dorsal to the intestine and outside of the cement glands. It is convoluted in each of the free segments, and when the eggs are mature it fills practically all the space between the intestine and cement glands and the dorsal and lateral walls of the body. The oviducts open out of the dorsal surface of the genital segment, and just before reaching the external openings, the vulvae, each receives the duct of the cement gland on its side of the body.

The cement glands are situated on either side of the midline in the third, fourth, and fifth segments, dorsal to the intestine; they are cylindrical in the fifth segment with a wide diameter, are narrowed rapidly in the fourth segment, and just reach across the posterior margin of the third segment; they are not segmented.

The sperm receptacle is a large sack lying ventral to the intestine in the posterior end of the fifth and the anterior portion of the genital segments. It has already been noted that the spermatophores are exceptionally large, and this sack is correspondingly large, since it must hold the contents of two spermatophores.

The excretory glands are not readily located, but apparently they are situated at the posterior margins of the thoracic segments, espe-

cially in the lobes of the dorsal plates and inside the bases of the swimming legs.

Internal specific characters of male.—Digestive canal and nervous system similar to those of the female. Testes situated at the posterior end of the cephalothorax near the dorsal surface, with the sperm ducts leading back to the spermatophore receptacles in the genital segment. These receptacles occupy practically the whole of the genital segment, and each opens on the ventral surface near the center of its half of the posterior margin. Just in front of the receptacle the walls of the sperm duct are thickened and become glandular for the secretion of the cement substance which forms the outside wall or case of the spermatophore.

The excretory glands are more difficult to locate than in the female, and it is impossible to recognize them with certainty in any sections thus far examined.

(*atlantica*, of or belonging to the Atlantic Ocean.)

Remarks.—This species was found clinging to the very tips of the gill filaments, and while the total number of specimens is large, the yield from each fish was small. Four of the largest sharks examined contributed only three specimens, two males and a female.

When removed and placed in water both sexes are very restless and keep up a constant motion of all their appendages. The male by reason of the plumose setae on his swimming legs is able to kick himself about, and even to swim in a bungling fashion, but the female simply rolls around, and is practically helpless.

This species has already been contrasted with the one obtained from the hammer-head shark in the West Indies on page 239 of volume 44 of these Proceedings. The simplest way to tell these two species is by the presence or absence of a knob on either margin of the cephalothorax and by the visibility or invisibility of the fifth legs in dorsal view.

Genus EUDACTYLINA P. J. van Beneden.

Eudactylina Beneden, Bull. Acad. Roy. de Belgique, vol. 20, 1853, p. 235.
Eudactylina Olsson, Lunds Univ. Arsskrift, vol. 5, 1868–9, No. 8, p. 24.
Eudactylina Valle, Boll. Soc. Adriatica Sci. Nat. Trieste, vol. 6, 1880, p. 67.
Eudactylina T. and A. Scott, British Parasitic Copepoda, 1913, p. 125.

Generic characters of female.—Head fused with first thorax segment and covered more or less completely with a carapace, the latter usually emarginate posteriorly. Four free thorax segments, without dorsal plates or lateral processes, the first three with biramose swimming legs, the last one (fifth segment) with uniramose legs. Genital segment considerably smaller than the fifth segment; abdomen still smaller and from one- to three-jointed.

First antennae short and stout, five- to seven-jointed, the basal or subbasal joint usually armed with curved claws. Second antennae three-jointed, the terminal joint a stout curved claw. Mouth tube small, conical, and bluntly rounded; mandibles slender, stylet-shaped; first maxillae biramose, rami slender and fringed with hairs; second maxillae three-jointed, the last joint a small claw; maxillipeds large, with strong terminal chelae. First four pairs of legs short, biramose; rami of first pair two-jointed, of second, third, and fourth pairs three-jointed; exopod of second pair often modified; fifth pair uniramose, one-jointed. Anal laminae short but well armed with setae; egg strings as long as the body; eggs large, not much flattened.

Generic characters of male.—General body form and segmentation as in the female, but smaller, longer, and more slender. Genital segment and abdomen together forming half the entire length, the former considerably larger than the fifth segment. Abdomen three- or four-jointed.

First antennae stout, with a strong curved claw at the tip; second pair also stout, with two large terminal claws and spines on the first two joints. Maxillipeds with a normal basal joint and a long terminal claw not chelate. Swimming legs like those of the female, except that the second exopod is not modified. Anal laminae long and narrow, tipped with hooked claws.

Type of the genus.—*Eudactylina acuta* P. J. van Beneden, monotypic.

KEY TO THE SPECIES.

1. Entire body rough and covered with short, coarse hairs; second thorax segment not sensibly smaller than the others ____ 2
1. Entire body smooth, without hairs or spines except on the appendages; second thorax segment distinctly smaller than the others ____ 4
1. Frontal end of carapace and two abdomen segments covered with spinules; fourth and fifth segments fused ____ *insolens* T. and A. Scott, 1912
2. Free thorax segments considerably wider than long; egg strings elongate and filiform; eggs minute and strongly flattened ____ 3
2. Free thorax segments as long as wide or longer; egg strings wide and short; eggs large, not much flattened ____ *minuta* T. Scott, 1904
3. Head triangular, narrowed to a rounded point anteriorly; second, third, and fourth segments wider than the head, obcordate; abdomen four-jointed; anal laminae wide, flattened ____ *squatinae-angeli* Hesse, 1883
3. Head tetragonal, narrowed but little anteriorly; second, third, and fourth segments transversely elliptical; abdomen two-jointed; anal laminae slender and cylindrical ____ *aspera* Heller, 1865
4. Head oblong, narrowed anteriorly; maxillipeds strongly chelate, jaws about equal, their ends shutting together ____ 5
4. Head quadrate, as wide anteriorly as posteriorly; maxillipeds not chelate, claw longer than basal joint and shutting against a knob ____ 6
5. Second segment considerably smaller than the others; anal laminae broad and flattened, each with three rudimentary spines and a fringe of hairs on the inner margin ____ *acuta* P. J. van Beneden, 1853

5. Second segment larger than the others; anal laminae narrow and cylindrical, each with two rudimentary spines and without the fringe of hairs ---------- *similis*, T. Scott, 1902
5. Second segment the same size as the third and fourth; anal laminae flattened, each with five stout spines and without the fringe of hairs; exopod of first legs one-jointed ---------- *acanthii* A. Scott, 1901
6. A large spine at each posterior corner of the carapace; no claws on first antenna; abdomen two-jointed ---------- *nigra* Wilson, 1905, p. 67
6. No spines at posterior corners of carapace; two huge curved claws on the first antennae; abdomen one-jointed ---------- *uncinata* Wilson, 1908

Remarks.—Hesse[30] described and figured two new species, both of which he referred to the present genus, and to which he gave the specific names *musteli-laevis* and *charchariae-glauci.* While it is fairly probable that these species do belong here, we cannot accept them as he has presented them on account of serious discrepancies in his text and figures. In his dorsal view of *musteli-laevis* (fig. 1) there are five free segments in front of the genital segment and the fifth legs are on the latter. In lateral view (fig. 2) the fifth legs are on the fourth free segment. In figure 1 the abdomen is one-jointed, in figures 2 and 11 it is two-jointed, and in figure 10 it is three-jointed. In figure 2 the first thorax segment is fused with the head, while in figure 14, which is a lateral view of *charcharias-glauci*, the first segment is distinctly separated from the head. The dorsal view of this latter species (fig. 13) shows the egg tubes coming out from under the fifth legs. The lateral view (fig. 14) shows that these legs are on the fifth free segment and distinctly separated from the genital segment. Furthermore figure 13 shows a pair of stalked eyes, of which Hesse stated in his text: "Les yeux sont petits et placés près du bord frontal à l'extrémité de deux petits appendices tubuliformes" (p. 11). Due allowance can be made for poor figures and faulty descriptions, but when both unite in ascribing a pair of stalked eyes to a parasitic copepod, prudence demands that the species be ignored until future investigation determines what it is and where it belongs.

EUDACTYLINA NIGRA Wilson.

Plate 11, figs. 76–85; plate 12, fig. 86.

Eudactylina nigra WILSON, Proc. Biol. Soc. Washington, vol. 18, 1905, p. 131.

Host and record of specimens.—Twenty specimens, all females, were obtained from the gills of the sand shark, *Eugomphodus littoralis*, at Woods Hole in July, 1902, by the author. One has been selected to serve as a type of the species with Cat. No. 54070, U.S.N.M. The others become paratypes with Cat. No. 54071, U.S.N.M. Another lot of 60 specimens, also all females, was ob-

[30] Ann. Sci. Nat. Zool., vol. 16, 1883, pp. 8–13, pl. 14, figs. 1–23.

tained from the same locality and host July 9, 1904, and have been given Cat. No. 54072, U.S.N.M.

External specific characters of female.—Body elongate, largest at the anterior end and regularly tapered to a blunt point at the posterior end. There are four free thorax segments, diminishing regularly in width but of very different lengths, the fifth segment being much the longest and the second (first free) segment the shortest. The first segment, being fused with the head, is always partially and sometimes completely hidden beneath the posterior margin of the carapace. Occasionally it is quite distinctly separated from the head, but this is due to lack of maturity, the tendency being for it to appear plainly in undeveloped females, and then gradually disappear as development progresses.

Carapace nearly as long as the second and third segments together, subquadrilateral in outline with rounded corners and a deeply emarginate posterior border. The lateral margins are also often more or less emarginate. The first antennae are prominent on the anterior margin, and their basal joints have an appearance similar to the frontal plates in the Caligidae. The dorsal surface of the carapace is grooved similarly to the cephalic area in the Caligidae, but no eyes can be detected. Both the second maxillae and the maxillipeds project beyond the margins of the carapace and stand out prominently in dorsal view.

There are four pairs of biramose swimming legs, together with a fifth and sixth pair, which are rudimentary and consist merely of a lamellar joint without rami. The sixth pair can be seen only on immature females and apparently disappear in the mature adult.

The egg sacks are attached to the sides of the genital segment near its posterior end. Each is fully as wide as the genital segment itself, considerably more than half as long as the entire body, and contains from 8 to 12 large eggs.

The abdomen is small, no longer and much narrower than the genital segment, and two-jointed. The basal joint is a little the wider while the terminal joint is much the longer, and is tipped with two tiny anal laminae, whose setae are hardly visible.

The first antennae are long and slender, and are made up of two large and stout basal joints and six short terminal ones.

The basal joints are fully half the entire length of the antenna, and on the dorsal surface the second of these joints ends in two stout claws which curve over ventrally on the posterior side of the third joint. On the ventral surface both basal joints are armed with a row of stout spines along their anterior border, while near the distal end of the second joint is a circular disk carrying two strong spines. From beneath this disk a large spine extends laterally, parallel with

the axis of the antenna. There are no other spines except a terminal tuft of 8 or 10 at the tip of the terminal joints, of which one is much longer than the others and curves around backward toward the body; the rest are straight.

The second antennae are stout and three-jointed; the basal joint is considerably swollen and carries a small spine on its outer margin. The second joint is inserted in such a manner as to stand out diagonally from the ventral surface of the head. It bears on its anterior surface at the center a large elliptical plate of corrugated chitin, which is raised considerably above the surrounding surface. The terminal joint is in the form of a strong claw, which is strengthened at its base by two short and stout spines.

The mouth tube is an elongated oval in outline, the tip rather bluntly rounded. The opening is terminal or subterminal, and through it can be seen the tips of the stylet-shaped mandibles.

The first maxillae lie on either side of the mouth tube; each consists of a slender basal joint and two filiform rami, the endopod longer than the exopod and reaching beyond the tip of the mouth tube. Both rami are armed with short hairs arranged like those of plumose setae. The second maxillae are inserted far forward, close to the edge of the carapace; in fact they stand opposite the base of the mouth tube and are separated as far as possible from each other. Each is three-jointed, the two basal joints being considerably swollen and of about the same size, while the terminal joint is in the form of a short, straight claw. This claw is dentate along its posterior margin and also flanged with a circular flap near its tip. At the base or the claw and extending back some little distance on the outer surface of the second joint is a row of long stiff hairs.

The maxillipeds are large, even for this genus, and their pattern gives a ready means of identification of the species. They also are set close to the edge of the carapace and as far apart as possible, but are united across the midline by a broad band of chitin, which lies just behind the mouth tube. The basal joint is stout and tapers toward the distal end; it extends diagonally outward and backward beyond the margin of the carapace. At the base on the outer surface there is a medium-sized knoblike protuberance, which is corrugated and armed with short spines. The second joint is slightly narrower, but still stout and considerably longer than the basal joint. It is, however, strongly curved, so that the terminal joint is brought directly over the knob just mentioned. This terminal joint is in the form of a large chela, composed of a stout proximal and two distal portions. Of the latter the inner one is the inarticulate branch of the chela, and is a large knob with a corrugated inner surface. The outer portion, the articulate branch, consists of three parts, two

stout claws of about the same size standing side by side and slightly curved, and a large spatulate lamina, dorsal to them and standing on its edge with its flat side next to the claws.

The first four pairs of legs are biramose; in the first three pairs the endopods are distinctly three-jointed, while the exopods are indistinctly jointed, but the arrangement of the spines and notches on the lateral margins show that they are also three-jointed. Both rami of the fourth legs are indistinctly jointed, but again the spines and notches indicate that the exopods are three-jointed, while the endopods are only two-jointed. The basal portion of each foot consists of two joints imperfectly separated. The fifth legs consist of a semicircular flap on either side of the fifth segment, tipped with three small spines. Just in front of each fifth leg is a single spine standing out at right angles to the surface. In most females the rudiments of a sixth pair of legs may be seen on the genital segment behind the bases of the egg tubes. These are much more in evidence in young females, where they are fully as large as the fifth pair.

Color a dark brown or black, the brown due to the long and irregular ovaries, the black to the contents of the intestine. The eggs are also dark brown, so that the copepod shows plainly against the red background of the gills.

Total length, 2.40 mm. Carapace 0.50 mm. long, 0.40 mm. wide. Length of thorax, 1.70 mm.; of abdomen, 0.33 mm.; of egg strings, 1.30 mm.

Internal specific characters of female.—The esophagus enters the stomach near its anterior end and on the ventral surface. The stomach is not much enlarged and passes insensibly into the intestine posteriorly. The ovaries are situated in the posterior part of the cephalothorax near the dorsal surface. The oviducts are more or less convoluted, and when mature fill nearly all the space between the digestive canal and the body wall. The cement glands are in the dorsal portion of the genital segment and extend forward into the fifth segment. Each is slender, club-shaped with the swollen end anterior, and distinctly segmented. The semen receptacle is in the posterior portion of the genital segment, ventral to the oviducts and cement glands. The large maxillipeds have a correspondingly large set of powerful muscles, which are attached to the dorsal surface and sides of the cephalothorax.

Nauplius.—The nauplius is ovate in outline, slightly wider anteriorly, the length about twice the width, the margins very evenly curved. The plumose setae on the first antennae are longer than the appendages themselves, on the other two pairs they are about the same length as the appendages. The endopods of the second antennae and mandibles have five setae, the exopods two. The balancers are close to the posterior end of the body, are very narrow,

of the same diameter throughout, and are bluntly pointed. The color of the appendages and body margins is that of transparent cartilage; the center of the body is opaque and dark gray. The nauplius eye is not visible in any of the specimens examined.

Remarks.—This species is very abundant on the gills of the sand shark, where they appear as minute dark brown or black lines against the red filaments. They are firmly fastened by their maxillipeds, which are clasped around the filaments, with the terminal chelae buried in the tissue of the filament. When removed they always retain some of the tissue still clasped in the chelae, together with an abundance of slime, and must be thoroughly cleaned before they can be properly preserved. When placed in water they wriggle about like a worm, but can not move definitely in any direction. They get hold of any fragments of tissue or waste material that may be within reach and cling to them as tenaciously as to the gill filaments, but if they are well cleaned when removed and are kept free from such waste material they will live three or four days. No males could be found, although the gills of many fish were searched diligently for them.

Genus LAMPROGLENA Nordmann.

Lamproglena Nordmann, Mikrographische Beiträge, 1832, pt. 2, p. 1.

Lamproglena Milne Edwards, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 487.

Lamproglena Claus, Zeit. für wiss. Zool., vol. 25, 1875, p. 352.

Lamproglena Brian, Copepodi parassiti dei Pesci d'Italia, 1906, p. 78.

Generic characters of female.—Head partially separated from the first thorax segment and divided by deep lateral sinuses into an anterior and posterior portion. First segment only half the width of the head and very short, forming a neck; second, third, and fourth segments increasing in size, the latter as large as the head; fifth segment smaller than the first; genital segment nearly spherical and much wider than the fifth segment. Abdomen made up of three segments, diminishing considerably in length and slightly in width from in front backwards, the three together nearly as long as the rest of the body.

First antennae indistinctly jointed, heavily armed with setae; second pair slender, four-jointed, strongly curved, setose and not uncinate. Mandibles awl-shaped, with a double curve. Second maxillae powerful prehensile organs, armed with stout claws. Maxillipeds also prehensile but weaker, with multiple terminal claws. First four pairs of legs biramose, the rami indistinctly two-jointed; fifth legs uniramose, one-jointed, and very small. Male unknown.

Type of the genus.—*Lamproglena pulchella* Nordmann, first species.

Remarks.—Nordmann described and figured the type species in considerable detail and then added on page 134 of the same paper two other species, but gave no figures for these and briefly described one of them only. These two species were found upon different hosts in the Red Sea, *L. lichiae* upon *Lichia aculeata* and *L. hemiprichii* upon *Hydrocycnus dentex*. Neither of them have been seen by any investigator except Nordmann, and it is impossible on the basis of the data he gives to distinguish them from the type species or from each other.

Genus DONUSA Nordmann.

Donusa Nordmann, Bull. Soc. Imp. Nat. Moscou. vol. 37, 1864, p. 494.

Generic characters of female.—Head fused with first thorax segment to form a triangular cephalothorax, pointed anteriorly; second, third, fourth, and fifth segments free, each with a pair of biramose swimming legs. Genital segment very small, enlarged posteriorly. Abdomen three-jointed, tapered posteriorly; anal laminae slender, elongate, jointed near their tips, armed with nonplumose setae.

First antennae filiform with enlarged basal joints; second pair also filiform and setose, not uncinate. Second maxillae and maxillipeds large, strong, and tipped with stout claws. Five pairs of biramose legs, rami three-jointed. Male unknown.

Type of the genus.—*Donusa clymenicola* Nordmann, monotypic.

Remarks.—This genus was founded upon two female specimens taken on the west coast of Sweden from the Annelid, *Clymene lumbricalis* Fabricus. No one except Normann has ever seen specimens of the genus and no other investigator has even mentioned them except Levinsen, who published a list of parasitic copepods found upon Annelids and merely mentioned *Donusa* in the list. The genus seems to be well established, however, and both Nordmann's description and figures are clear-cut and decisive.

The fact that the fifth legs are biramose, with three-jointed rami, like the four preceding pairs, is the most distinctive character of the genus.

BASSETTITHIA, new genus name.

Bassettia Stebbing, Willey's Zoological Results, pt. 5, 1900, p. 672.

External generic characters of female.—Head fused with first thorax segment, the resulting cephalothorax globose, with strongly convex margins. Second, third, and fourth segments indistinctly separated; fifth and genital segments fused, oblong oval in outline, longer and wider than the rest of the body, with projecting posterior corners. Abdomen one-jointed; anal laminæ narrow and tipped with minute setæ.

First antennae nine-jointed; second pair prehensile with a stout terminal claw. First three pairs of swimming legs reduced to mere

tubercles without rami; fourth pair with minute, one-pointed rami. Male unknown.

Type of the genus.—*Bassettithia congri* (Stebbing), monotypic.

Remarks.—This genus was established in the year 1900 by Rev. T. R. R. Stebbing and was named in honor of Dr. P. W. Bassett-Smith, R. N. The name given by Stebbing. however, had been preoccupied by Ashmead in 1887 for a genus of insects, and in its place is suggested the altered form given above, which includes a portion of the Smith as well as all of the Bassett.

Genus PSEUDOCLAVELLA Bassett-Smith.

Pseudoclavella BASSETT-SMITH, Ann. Mag. Nat. Hist., ser. 7, vol. 2, 1898, p. 92.

External generic characters of female.—Head fused with first thorax segment, the two globose and covered with a dorsal carapace, which is cleft at the center of the posterior margin. Second thorax segment free, narrower than the head; the remaining thorax segments fused with the genital segment into an elongated, spindle-shaped body, considerably narrowed posteriorly, and four times as long as the cephalothorax. Abdomen minute and one-jointed; anal laminae lamellar.

First antennae indistinctly three-jointed, setose; second pair two-jointed, the terminal joint a stout, strongly curved claw. First maxiliae minute, slender, and straight; second pair three-jointed, the terminal joint a curved claw. Maxilliped long and slender, the basal joint projecting beyond the margin of the head, the second joint long and filiform, the terminal claw short and curved. First two pairs of legs biramose, rami two-jointed except the endopod of the first pair, which has but a single joint. Third and fourth legs uniramose, one-jointed, tipped with setæ. Egg tubes as long as the entire body, eggs large and well flattened.

Type of the genus.—*Pseudoclavella ovalis* Bassett-Smith, monotypic.

Remarks.—The name chosen for this genus is unfortunate for the following reasons: Oken[31] first proposed the genus *Clavella*, with the type species *uncinata*, and both stand to-day as he established them, but they are Lernaeopods and not Dichelesthiids. Krøyer[32] made Oken's *Clavella* a synonym of Cuvier's *Anchorella*, and then on page 195 he restored the genus *Clavella*, but took as its type the species *hippoglos* which is a Dichelesthiid. Milne Edwards and subsequent writers followed Krøyer's mix-up and *Clavella* was regarded as a Dichelesthiid genus until Poche in 1902 showed that if *Clavella* is to be retained at all it must be as a Lernaeopod genus,

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[31] Lehrbuch der Naturgeschichte, 1815, p. 357.

[32] Naturhistorisk Tidsskrift, vol. 1, 1837, p. 193.

and he proposed the name *Hatschekia* for the Dichelesthiid genus. This has been universally adopted, but it leaves us with *Clavella*, a recognized Lernaeopod and *Pseudoclavella*, just as evidently a Dichelesthiid and not in the slightest degree a "pseudo" of the Lernaeopod.

Genus PSEUDOCYCNUS Heller.

Pseudocycnus Heller, Reise der *Novara*, 1865, p. 218.
Pseudocycnus Bassett-Smith, Proc. Zool. Soc. London, 1899, p. 475.
Pseudocycnus Brian, Copepodi parassiti dei Pesci d'Italia, 1906, p. 76.

External generic characters of female.—Head fused with first thorax segment, second and third segments free; fourth and fifth segments fused with the genital segment into a cylindrical body several times longer than wide, and of about uniform diameter throughout its length. Abdomen one-jointed; anal laminae elongate-lanceolate, one-third as long as the entire body, very narrow. Egg strings filiform, longer than the body, eggs minute, numerous, and strongly flattened.

First antennae short and tapering, with a tuft of setae at the tip; second antennae prehensile, armed with a stout claw. Mouth tube short and conical.

First maxillae filiform and setaceous; second maxillae stout and uncinate; maxillipeds large, with a toothed terminal claw. First legs single laminae without rami or setae; second legs biramose, rami one-jointed, setiferous; third and fourth legs uniramose, one-jointed, with terminal setae.

Internal generic characters of female.—Esophagus entering the stomach on the ventral surface near the anterior end; intestine narrowed through the second and third thorax segments, then widened in the fused posterior body. Ovaries in the posterior portion of the cephalothorax near the dorsal surface; oviduct first narrow, then widened in the genital segment and convoluted along the lateral margins. The convolutions are small but quite regular, especially toward the posterior end. The external opening of the oviduct and hence the egg strings are dorsal to the abdomen. The cement glands lie side by side on the median line beneath the intestine. Each is filiform, very narrow, and about the same diameter for its entire length, without segmentation. The semen receptacle lies on the ventral surface of the genital segment beneath the intestine; it is pointed anteriorly and three-lobed posteriorly.

External generic characters of male.—Head fused with the first thorax segment, the two joined to the second segment by a short neck. Subsequent thorax and genital segments increasing regularly in width; abdomen abruptly reduced to less than half the width of the genital segment, one-jointed. Anal laminae flattened, much longer than wide, bluntly rounded, and armed with minute spines.

First antennae indistinctly jointed; second pair prehensile; second maxillae and maxillipeds similar to those of the female but relatively stronger. First swimming legs single laminae, unarmed; second pair biramose, rami one-jointed; third pair uniramose, one-jointed; fourth pair uniramose cylinders, one-jointed and half as long as the body.

Type of the genus.—Pseudocycnus appendiculatus Heller, monotypic.

Remarks.—The name of this genus is even more unfortunate than that of the preceding one. In his Histoire Naturelle des Crustacés (1840) Milne Edwards described and figured a new genus of parasitic copepods, to which he gave the name *Cycnus.* But Hubener had used this name 24 years before for a genus of Lepidoptera, and hence it can not stand for the parasitic copepods.

P. J. van Beneden[33] described and figured a copepod parasite which he claimed as a new genus and called *Congericola.* This has since been proved to be generically identical with Milne Edwards specimens, but specifically distinct. Accordingly the name *Cycnus* must be dropped and the name *Congericola* retained. But this leaves us the embarrassing necessity of retaining *Cycnus* as a valid genus among the moths and *Pseudocycnus* among the parasitic copepods, the two, of course, not being in the remotest degree related to each other.

PSEUDOCYCNUS APPENDICULATUS Heller.

Plate 12, figs. 87–96.

Pseudocycnus appendiculatus HELLER, Reise der *Novara*, 1865, p. 218, pl. 22, fig. 7.

Pseudocycnus appendiculatus BRIAN, Copepodi parassiti dei Pesci d'Italia, 1906, p. 76.

Pseudocycnus appendiculatus BRIAN, Resultats des Campagnes scientifiques du Prince de Monaco, 1912, fasc. 38, p. 15, pl. 5, fig. 3; pl. 6, fig. 11.

Host and record of specimens.—Sixteen females and a male were taken August 18, 1886, 100 miles south of Marthas Vineyard from the gills of the albacore, *Orcynus alalonga*, by the schooner *Grampus.* The females have received Cat. No. 12663, U.S.N.M., while the male has been separated and given Cat. No. 54073, U.S.N.M.

External specific characters of female.—Cephalothorax ovate, narrowed anteriorly, with somewhat concave anterior and lateral margins, and covered with a dorsal carapace. The posterior corners of this carapace are prolonged into wide well-rounded lobes above the basal joints of the maxillipeds. Anteriorly the dorsal and ventral surfaces are fused into a thickened margin which projects a little on either side external to the base of the antenna. The first thorax segment

[33] Bull. Acad. Belgique, vol. 21, 1854, p. 583.

appears in dorsal view only as a narrow neck between the posterior lobes of the carapace and is less than one-fourth the width of the head. The second, third, and fourth segments are abruptly widened to equal the carapace, with sharply convex lateral margins. Along the anterior border of these segments on either side is the rudiment of a dorsal plate appearing in the form of a thickened margin, which projects slightly. The fused posterior body is a little narrower than the fourth segment, about six times as long as wide, with nearly straight sides. It shows no traces of segmentation, but is divided quite regularly by the attachment of transverse rows of dorsoventral muscles. The egg strings are attached to its posterior margin close to the midline and over the base of the abdomen, and are longer than the entire body. The abdomen is about half as wide as the genital segment, one-jointed, and obliquely truncated at its posterior corners, to which are attached the anal laminae. These latter are lanceolate, somewhat flattened dorsoventrally, and taper to an acute point. Each is about one-third as long as the entire body, is eight times as long as wide, and is destitute of spines or setae.

The first antennae are indistinctly three-jointed and tapered, with a tuft of short spines at their tip. The second antennae are evidently the chief organs of prehension, and project nearly their whole length in front of the anterior margin. Each one is made up of a stout basal joint and a strongly curved terminal claw, which is usually carried at right angles to the basal joint, thereby increasing its holding power.

The mouth tube is short and rather wide and tapers to a blunt point. On either side of its base are the first maxillae, which are filiform, three-jointed, and destitute of setae or claws. The second maxillae are attached just outside of the first pair and are also three-jointed. The basal joint is swollen and filled with powerful muscles; the second joint is rather slender, its outer margin is crenate and is armed with a row of short spines; the third joint is in the form of a small curved claw.

The maxillipeds are powerful prehensile organs; the terminal claw has a sharp spine or tooth on its inner margin near the center.

The first swimming legs project from the sides of the first segment just inside the basal joints of the maxillipeds and so close to them as to be partially concealed. Each is made up of a single flattened lamina without setae or spines. The second and third swimming legs are on the ventral surface of their respective segments; the second pair is biramose, the rami one-jointed, the exopod armed with four spines, and the endopod with three. At the outer corner of the basal joint, outside the exopod, is a large curved spine, longer than

the rami plus their spines. The third legs are uniramose, one-jointed, and armed near their tip with three minute spines. The fourth legs project from the lateral margins of the fused posterior body, just behind the rudimentary plates of the fourth segment. Each is a minute, uniramose, fingerlike process, with two tiny spines at its tip.

Color.—Fresh living specimens are bright red, owing to the blood they contain. The elongate convoluted oviducts are brownish black, deepening into jet black in the deeper portions of the convolutions, especially toward the posterior end of the body. The egg cases are dark brown. Preserved material is light brownish yellow, the dorsoventral muscles slightly darker.

Total length, including the posterior processes, 16 mm. Width of carapace, 1.50 mm. Width of posterior body, 1.90 mm. Length of egg strings, 21 mm.

Specific characters of male.—General form that of a Greek cross, due to the elongate, rigid fourth legs, which project from the lateral margins near the center of the body. Cephalothorax, the largest division of the body, subovate, nearly as wide as long, with a slight rostrum projecting from the center of the anterior margin, and a chitinous framework visible through the dorsal surface. Both pairs of antennae show in front of the carapace in dorsal view, while the second maxillae project considerably on either side, and the maxillipeds stand behind the posterior corners like a pair of large lobes. Behind the head and more or less fused with it the first thorax segment appears as a short neck, reduced to less than half the width of the head. The second segment is considerably wider and at least four times as long as the first, with the swimming legs projecting from the lateral margins. The third segment is a little wider, but shorter, than the second, and in the living male the third legs project from its sides, but in preserved material they shrink back so as to be invisible in dorsal view. The fourth segment is still wider than the third and longer than the second, and from its lateral margins extend the fourth legs, which are long, cylindrical, and rigid, and which extend outward and backward at an angle of about 60° with the body axis. The fifth and genital segments are the same width as the fourth and are suboval in outline, with a single long and jointed seta on each lateral margin near the center. The abdomen is reduced to less than half the width of the genital segment, with concave lateral margins and a sinus at the center of the posterior margin. The anal laminae are longer than the abdomen and widely divergent; each is flattened dorsoventrally and emarginate at the tip, which is bluntly rounded and armed with a row of minute spines, one of which, at the tip of the lamina, is larger than the others.

The first antennae are apparently three-jointed and taper from the base to the tip. The setae at the tip are not symmetrically arranged,

but one or two are terminal and all the rest are on the posterior margin, next to the carapace. The second antennae are developed into powerful prehensile organs; their basal joints are long, much swollen, and filled with strong muscles, which are supported by several chitin bands and processes.

The terminal claw is strongly curved and sharply pointed, with a small and sharp spine near the base.

The rostrum is short and stout, with the upper lip obtusely rounded and the lower one more acute. The first maxillae are relatively large and three-jointed, the joints subequal in length. The two basal joints are moderately stout, the terminal one is slender and bifid at the tip. with the inner ramus longer than the outer. The second maxillae are made up of a rather stout basal joint, a narrower second joint of about the same length, and a spine-like terminal claw. The distal end of the second joint is armed with closely placed, acute, and more or less curved spines arranged in several rows, mostly along the outer margin.

The maxillipeds are composed of a very large and stout basal joint and a strongly curved terminal claw. The tip of this claw, and also the one on the second antenna, is of a dark red amber color. On the inner margin of the claw near the center is a smaller secondary claw or tooth, and proximal to this the claw is at least partly divided by a joint.

The first swimming legs consist of a single flattened lamina, with a tiny spine at its tip. They are so close to the maxillipeds that they are largely concealed beneath the basal joints of the latter, with only their tips visible. The second legs are biramose, the basal joint broad and stout, the rami short, stout, and one-jointed. The outer margin of the basal joint carries a long jointed seta; the exopod is larger than the endopod and is terminated by four stout spines, the outer of which is the largest. The endopod has three similar spines at the outer end and a fringe of fine hairs along the inner margin. The third legs consist of a single lamina, like the first legs but smaller, which is armed with three spines near its tip.

Color.—The living male is bright red from the presence of blood like the female; preserved material is light cartilage yellow, the tips of the claws of the second antennae and maxillipeds and the chitin framework of the appendages a dark amber red.

Total length, 4 mm. Cephalothorax 1.20 mm. long, 1.10 mm. wide. Body 0.80 mm. wide. Fourth legs 1.50 mm. long.

Remarks.—The fish were brought in alive by the *Grampus* and the parasites were taken from them by Mr. Richard Rathbun and studied while still living. He made detailed notes on their appearance and structure, and Mr. J. H. Blake made drawings of both a male and a

female. These notes and drawings are here for the first time made public.

Heller first established this genus with the present species as its type. His two figures, one of the dorsal and the other of the ventral surface, differ in minor details from those here given. The chief difference is in the number of the transverse divisions of the fused posterior body. He represented only 19 of these and left the posterior third of the body entirely free as though no divisions existed there. Blake has represented 25 divisions and they extend to the very posterior end of the body. His drawing was made from a living specimen, while Heller had only alcoholic material in which the posterior divisions were no longer visible.

In two preserved specimens of the present lot, which were cleared in cedar oil after having remained in alcohol for more than 30 years, the divisions are exactly as Blake represented them.

PSEUDOCYCNUS BUCCATUS, new species.

Plate 12, figs. 97–100; plate 13, figs. 101–103.

Host and record of specimens.—Eight females were taken by the author from the gills of a Spanish mackerel, *Scomberomorus maculatus*, August 13, 1900, at Woods Hole, Massachusetts. One of these has been selected for the species type and has received Cat. No. 54077, U.S.N.M., while the others become paratypes with Cat. No. 54078, U.S.N.M. Another lot of five females was obtained from the gills of the cero, *Scomberomorus cavalla*, at Woods Hole July 29, 1887, by Vinal N. Edwards. These have been given Cat. No. 54079, U.S.N.M.

External specific characters of female.—General body form a narrow, elongated cylinder. Cephalothorax obovate, considerably widened anteriorly and narrowed posteriorly. Second and third thorax segments free, the same width as the head, the second segment twice as long as the third, both segments with convex lateral margins. Fourth, fifth, and genital segments fused into a cylindrical body five times as long as wide with a uniform diameter. Egg strings about as long as the body and one-third its diameter. Abdomen abruptly reduced to half the diameter of the genital segment, one-jointed; anal laminae short and conical, each tipped with a single seta.

First antennae minute, cylindrical, indistinctly six-jointed, with a few minute setae on the terminal joint and short bristles scattered over the surface of all the joints. Second antennae three-jointed, the two basal joints moderately swollen, the terminal joint a long curved claw, with an accessory spine or tooth on its concave margin near the center and another much smaller one on the inner margin near the base. Mouth tube conical and close behind the second antennae;

first maxillae filiform; second pair with a swollen basal joint, a slender second joint, and a short spine-like terminal joint or claw. The outer margin of the second joint and the terminal claw are armed with minute teeth.

The maxillipeds are the characteristic appendages of this species. The basal joints are enlarged so as to occupy the entire sides of the cephalothorax, reaching forward to the bases of the second antennae and projecting backward outside of the narrowed cephalothorax beyond the anterior margin of the second segment. Each basal joint is apparently made up of two parts, posterior and anterior, separated by a well-defined groove. The posterior part carries the long, slender, and strongly curved terminal claw, while the anterior part is like a large pad with a rounded tip. Both parts carry a heavy fringe of hair, that on the anterior part being twice the length of that on the posterior. The swimming legs are reduced to mere vestiges; the first pair are represented by tiny knobs on the ventral surface of the cephalothorax inside the bases of the maxillipeds. The second pair appear as a bilobed lamina on either side of the second segment. The third pair are short, flattened laminae on the third segment, while the fourth pair are entirely lacking. None of the legs have either spines or setae.

Color a light flesh red, the convolutions of the oviducts along the sides of the posterior body a dark brown, separated into stripes by transverse bands or dorsoventral muscles. Prehensile claws yellow, tipped with dark red.

Total length, 5 mm. Greatest diameter, 0.75 mm. Egg strings 4.50 mm. long, 0.25 mm. wide.

Specific characters of nauplius.—General shape an elongated cone, the bluntly pointed end posterior. The first antennae carry the usual pair of plumose setae and also a pair of stout spines at the base of the setae, on the posterior distal corner of the terminal joint. The exopods of the second antennae and mandibles carry four plumose setae, the endopods two. The endopods of the second antennae are longer than the exopods and are armed at their tip with a stout claw, between the bases of the setae. The endopods of the mandibles are much shorter than the exopods and unarmed.

The balancers are long needle-like spines, extending laterally at right angles to the body axis, so that the two fall in the same straight line.

At the posterior end of the body can be seen, inside of the skin, the tips of the appendages of the future metanauplis.

Color.—The dark mass of pigment in the center of the body is brown, the surrounding tissues are grayish white.

Total length, 0.25 mm. Width through the bases of the mandibles, 0.10 mm.

(*buccatus*, large-jawed, alluding to the maxillipeds.)

Remarks.—When removed from their host these parasites float in water, and even in alcohol, and it is very difficult to wet the outside of their bodies. So long as they remain alive they snap their maxillipeds viciously together in an endeavor to fasten to something. If a gill filament or similar fragment be left in the watch glass with them, they will all find it and fasten to it. They can not swim, but by wriggling their bodies in a manner similar to that of the mosquito larva they can propel themselves slowly, but such motion is entirely aimless, since they can not control its direction at all.

This species differs in many particulars from *appendiculatus* and when the male is discovered it is possible that it will demand a new genus for its reception. Its general make-up, however, is very much like that of the present genus, and it may be left here until the male is discovered.

The swimming legs are even more degenerate than those of *appendiculatus;* the fourth pair have entirely disappeared, and the first pair can be located only with the help of structures beneath the skin. The maxillipeds are different from anything heretofore found in that the basal joint is partly divided lengthwise.

Genus HATSCHEKIA Poche.

Clavella Krøyer, Naturhistorisk Tidsskrift, vol. 1, 1838, p. 196.
Clavella Milne Edwards, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 494.
Clavella P. J. van Beneden, Ann. des Sci. Nat., ser. 3, vol. 16, 1851, p. 99.
Cycnus Hesse, Ann. des Sci. Nat., ser. 6, vol. 8, 1878, art. 11, pp. 1–34, pls. 19–21.
Clavella T. Scott, 18th Ann. Report Fishery Board, Scotland, 1900, p. 159.
Clavella Brian, Atti Soc. Ligustica Sci. nat. e geog., vol. 13, 1902, p. 37.
Hatschekia Poche, Zool. Anz., vol. 26, 1902, p. 16.
Hatschekia T. and A. Scott, British Parasitic Copepoda, 1912, p. 112.

Generic characters of female.—Head and thorax separated, the former small and usually rounded. First two thorax segments more or less free, but often fused with each other, each with a pair of biramose swimming legs. The remainder of the thorax, including the genital segment, fused into a subcylindrical trunk, elongate and narrow. Abdomen short and one-jointed or lacking; anal laminae minute with tiny setae.

First antennae small, filiform, three to six jointed, the joints often indistinct. Second antennae short and stout, with strong terminal claws, and often with an accessory spine at the base of each antenna. Mandibles and first maxillae small, the latter as tiny knobs at the sides of the mouth, armed with spines. Second maxillae apparently lacking, maxillipeds slender and uncinate.

Two pairs of biramose swimming legs and occasionally the rudiments of a third and fourth pair. Egg strings short, eggs large and not much flattened.

Generic characters of male.—Head separated from the thorax and well rounded; entire thorax fused into a spindle-shaped or elongate body, whose segmentation is often very obscure. Abdomen more or less distinct, one-jointed; anal laminae much larger than in the female and armed with spines.

First antennae relatively longer and stouter than in the female; second pair projecting in front of the cephalon, and tipped with strong claws.

Maxillipeds very long and slender, projecting far beyond the margin of the head. Two pairs of swimming legs, uniramose and one-jointed.

Type of the genus.—*Hatschekia hippoglossi* (Krøyer), first species.

KEY TO THE SPECIES.

1. Head more or less spherical, the first and second thorax segments forming a distinct neck; trunk four to ten times the length of the head__________2
1. Head angular or widened transversely, no neck; trunk short and thick, from two to four times the length of the head______________________________6
2. First and second thorax segments completely fused, the two longer than the head; trunk cylindrical, lobed posteriorly______________________________3
2. First and second thorax segments completely fused, but less than one-third the length of the head; trunk flattened, no lobes_________________________4
2. First and second thorax segments only partially fused, much shorter than the head; trunk cylindrical, no lobes____________________________________5
3. Second thorax segment wider than the head; second legs visible in dorsal view; first antennae three-jointed__________2.33 mm., *linearis* Wilson, 1913
3. Second thorax segment narrower than the head; second legs not visible in dorsal view; first antennae five-jointed__9.50 mm., *hippoglossi* (Krøyer) 1837
3. Head, first two segments and trunk the same width; second legs visible in dorsal view; first antennae not distinctly segmented.
1.50 mm., *sargi* (Valle), 1882
3. Second thorax segment wider than the head; no legs visible dorsally; first antennae two-jointed__________________1.70 mm., *budegassae* (Krøyer), 1863
4. Trunk as wide as the head, first and second segments narrower; sides of trunk smooth; first antennae three-jointed___1.70 mm., *oblonga* Wilson, 1913
4. First and second segments as wide as the head, trunk much wider, its sides undulate__________________________________1.75 mm., *albirubra* Wilson, 1913
4. Trunk wider than the head, widest posteriorly, with three rows of knobs on the dorsal surface_______________________1.90 mm., *scari* (Krøyer), 1838
4. Trunk as wide as head, first and second segments narrower; one sinus on either side; first antennae five-jointed_______1 mm., *pygmaea* T. Scott, 1913
5. Head with a short and blunt posterior process; trunk six times as long as wide; first and second segments not distinct.
2.40 mm., *cornigera* T. Scott, 1919
5. Head smooth, trunk ten times as long as wide; first and second segments distinct and wider than the trunk_______________4 mm., *tenuis* (Heller), 1865

5. Head smooth; trunk three times as long as wide, with rudiments of third and fourth legs on its margins____________1.60 mm., *subpinguis* Brian, 1913
5. Head smooth; trunk five times as long as wide; first antennae two-jointed; no legs visible dorsally____________________1.75 mm., *mulli* (Beneden), 1851
6. Trunk as wide as or wider than the head and only twice as long or less, short and stout species____7
6. Trunk three or four times the length of the head and the same width or less, longer and narrower species____8
7. Head a quarter wider than long; trunk one-half wider than the head, with two lateral sinuses on each side; egg strings at right angles to body axis; first antennae five-jointed_____________________1 mm., *uncata* Wilson, 1913
7. Head a third wider than long; trunk not as wide as head, with a single sinus on either side; egg strings nearly parallel with body axis; first antennae four-jointed__________________2.75 mm., *iridescens* Wilson, 1913
7. Head the same width and length; trunk a fifth wider than the head, with three sinuses on either side, containing rudiments of a third and fourth pair of legs; antennae five-jointed______________0.85 mm., *insolita* Wilson, 1913
7. Head wider than long, trunk a half wider than the head, without sinuses; egg strings twice the entire length_________1.80 mm., *pinguis* Wilson, 1908
8. Head winged on either side, so as to be wider than long; first antennae twelve to twenty jointed____9
8. Head winged but fully as long as wide; first antennae short, only five to eight jointed ____10
9. Head large, triangular, widest at anterior margin; two free segments only a fifth the length of the head; genital segment pointed posteriorly; first antennae twelve-jointed________________2–3 mm., *crenilabri* (Hesse), 1878
9. Head widest at the center, transversely spindle-shaped; two free segments half the length of the head; genital segment rounded posteriorly; first antenna fourteen-jointed__________________2 mm., *labri-mixti* (Hesse), 1878
9. Head widest at the center; two free segments nearly as long as the head; genital segment uniform in width, rounded posteriorly; first antennae twelve-jointed____________________1.50 mm., *labri-donovaini* (Hesse), 1878
10. Trunk spindle or club shaped; first and second segments not separated from the trunk____11
10. Trunk club-shaped or with parallel sides; first and second segments distinctly separated; both pairs of legs visible dorsally___________________12
11. Trunk spindle-shaped, with lateral sinuses and rudiments of the third and fourth legs; head diamond-shaped.
1 mm., *labracis* (P. J. van Beneden), 1870
11. Trunk club shaped. larger posteriorly, without lateral sinuses; head nearly spherical; no legs visible dorsally__________1.50 mm., *cluthae* T. Scott, 1902
12. Two free segments half the length of the head; genital segment squarely truncated posteriorly, with a distinct abdomen and with its sides concave__________________________1.50 mm., *acantholabri-exoleti* (Hesse), 1878
12. Two free segments less than a third the length of the head; genital segment indistinguishably fused with the abdomen and pointed posteriorly, its sides convex____________________________2.30 mm., *labri-trimaculati* (Hesse), 1878
12. Head almost as long as the rest of the body; genital segment the same width throughout and squarely truncated posteriorly,
2 mm., *canthari-grisei* (Hesse), 1878
12. Head without lateral expansions; two free segments as long as the head; sides of genital segment straight____3 mm., *pagelli-bogneravei* (Hesse), 1878

Remarks.—From the above key it will be seen that Hesse is responsible for seven of the species in this genus. But the same is true here, as in all the work done by Hesse, the discrepancies and contradictions in his text and drawings are so numerous and so vital that his species can not be accepted until they have been described and figured anew. Take, for instance, his species *crenelabri.* Figure 10, plate 19, shows a dorsal view of an adult female, in which the first antennae have 14 joints, all the same length, and the second swimming legs are biramose, the exopod two-jointed, the endopod one-jointed, both well supplied with setae. Figure 11 is a dorsal view of the head and first two thorax segments, enlarged, in which the first antennae have 14 joints, but the first or basal joint is as long as all the others taken together; the second swimming legs are uniramose, one-jointed, and destitute of setae. Figure 12 is a ventral view of the head and first two thorax segments, in which the first antennae have 24 joints, all the same size, and the second swimming legs are uniramose, two-jointed, and well armed with setae. The creature presented as a male of this species in figure 1 of the same plate certainly does not belong to the genus *Hatschekia*, nor indeed to any other known copepod genus.

Clavella bramae.—P. J. van Beneden in his Les Poissons des Cotes de Belgique, leurs Parasites et leurs Commensaux (Bruxelles, 1870) mentioned on page 43 *Clavella bramae*, new species, as a parasite on the gills of *Cantharus brama.* He did not give a description or figure of the species, and no other investigator has either seen or mentioned it, so that it becomes a *nomen nudum.*

Clavella clavata.—Müller in his Zoologiae Danicae Prodromus, published in 1776, gave on page 227 a three-line description of a parasite which he called *Lernaea clavata.* Krøyer in Naturhistorisk Tidsskrift (vol. 1, 1837, p. 195) said in a footnote that he was unable to decided whether Müller's species belonged in the genus *Clavella*, because he had never seen it and Müller's description was unsatisfactory. On the next page, however, he placed it under *Clavella*, but with a question mark. These are all the data at present available and they are not sufficient to locate the species definitely.

Clavella obesa.—Richiardi published in 1880 what he termed a systematic catalogue of the crustacea living upon aquatic animals, which was included in the Report of the International Fisheries Exposition held in Berlin during that year. In this catalogue he gave the names of many parasitic copepods, which he claimed as new species, but which have never been described or figured. Among them was *Clavella obesa*, which thus becomes a *nomen nudum.*

Cycnus? budegasse.—Krøyer in his Bidrag til Kundskab om Snyltekrebsene, 1863, page 65, described and figured (pl. 12, fig. 3) a cope-

pod which he doubtfully referred to the genus *Cycnus*. He had but a single specimen, which had been in alcohol for 40 years, and he was hence unable to give many of the structural details. As we have already seen, the name *Cycnus* was preoccupied (see p. 58), and so this species can not retain that name, but it certainly does not belong to the genus *Congericola*, to which the true *Cycnus* species have been transferred. In size and general structure it corresponds well with the present genus, but it can not be definitely located until further details can be secured.

Genus DICHELESTHIUM Hermann.

Caligus, part ABILDGAARD, Skrivter af Naturhistorie Selskabet, vol. 3, 1794, p. 52.

Dichelesthium HERMANN, Memoire Apterologique, 1804, p. 125.

Dichelestium LATREILLE, Regne Animal de Cuvier, 1829, vol. 4, p. 200.

Dichelestium MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 485.

Dichelesthium M. J. RATHBUN, Fauna of New England, No. 5, Crustacea, 1905, p. 97.

Dichelesthium BRIAN, Copepodi Parassiti dei Pesci d'Italia, 1906, p. 67.

External generic characters of female.—Head fused with the first segment to form an angular cephalothorax; four free thorax segments without dorsal plates or processes, but the second and third segments are produced into lateral lobes. Genital segment oblong, narrower than the free segments and tapered posteriorly; abdomen small and one-jointed, attached to the ventral surface of the genital segment. First antennae eight-jointed, with scattered setae; second antennae large, cheliform, projecting in front of the head.

Mandibles stylet-shaped, toothed at the tip; first maxillae biramose, the exopod much larger than the endopod; second maxillae two-jointed and tipped with a small claw, sharp spines, and tufts of hair; maxillipeds stout, uncinate.

First two pairs of swimming legs biramose, the rami one-jointed; third legs flattened uniramose laminae, one-jointed; fourth and fifth legs wanting.

Egg strings slender, much longer than the body and straight, eggs strongly flattened.

External generic characters of male.—General body form the same as that of the female; head relatively larger, its lateral margins more angular. Only three free thorax segments, diminishing regularly in size; fifth and genital segments completely fused, narrow, and short; abdomen one-jointed.

Antennae, mouth parts, and swimming legs like those of the female, except that in the second legs the endopod is short and wide and bears two spines and a wide flattened plate, and the third legs are relatively shorter and broader.

Internal generic characters.—The esophagus is inclined forward at an angle of 45° and enters the extreme anterior end of the stomach. The latter is enlarged only a little, and passes into a wide intestine which runs the entire length of the body and is contracted into a short rectum.

The ovaries are situated on either side of the intestine near the dorsal surface of the first thorax segment. The oviducts, starting from the anterior ends of the ovaries, curve downward, outward, and backward along the sides of the thorax to the vulvae. When fully developed they fill nearly the entire space between the intestine and the body wall. The eggs are scattered loosely through the oviducts, are not arranged in any definite order, and are not flattened. The sperm receptacle is just inside the ventral body wall and is oblong, with rounded ends.

In the male the testes and sperm ducts are arranged similarly with the spermatophore receptacle near the posterior end of the genital segment.

In the female the cement glands lie on either side of the intestine, ventral to the oviducts, and are confined to the genital segment. They are about the same diameter throughout their anterior half, which is glandular and not segmented, while the posterior half is much narrowed.

From the supraesophageal ganglion branches go to the two pairs of antennae and the front of the head; from the infraesophageal ganglion similar branches go to the various mouth parts and the first swimming legs. A ventral trunk runs back through the thorax to the anterior end of the fifth segment, where it divides into two branches, which separate a little and reach the posterior end of the genital segment. On either side of the intestine in each segment posterior to the first is a band of dorsoventral muscles which aid in the extrusion of the eggs.

Type of the genus.—*Dichelesthium oblongum* (Abildgaard), monotypic.

DICHELESTHIUM OBLONGUM (Abildgaard).

Plate 13, fig. 105.

Caligus oblongus Abildgaard, Skrivter af Naturhistorie Selskabet, vol. 3, 1794, p. 52, pl. 5, figs. 4–11.

Dichelestium sturionis Hermann, Mémoire Apterologique, 1804, p. 125, pl. 5, figs. 7–8.

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Dichelestium sturionis Bosc, Historie Naturelle des Crustacés, 1830, vol. 2, p. 223, pl. 18, *b*, fig. 2.

Dichelesthium sturionis Nordmann, Mikrographische Beiträge, 1832, p. 41.

Dichelestium sturionis BURMEISTER, Beschreibung einiger neuen oder weniger bekannten Schmarotzerkrebse, 1832, p. 328.

Dichelestium sturionis RATHKE, Nova Acta Academiae Leopoldinae Carolinensis, 1836, vol. 19, p. 127, pl. 17, figs. 1–17.

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Dichelestium sturionis GUERIN, Inconographie du Regne Animal, 1840, p. 43, pl. 35, fig. 10*a–c*.

Dichelestium sturionis MILNE EDWARDS, Histoire Naturelle des Crustacés, 1840, vol. 3, p. 485, pl. 39, fig. 4; Atlas du Regne Animal de Cuvier, 1849, pl. 79, fig. 2.

Dichelestium sturionis BASSETT-SMITH, Proc. Zool. Soc. London, 1899, p. 473.

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Dichelesthium sturionis BRIAN, Copepodi Parassiti del Pesci d'Italia, 1906, p. 67.

Dichelestium oblongum NORMAN and T. SCOTT, Crustacea of Devon and Cornwall, 1906, p. 215.

Dichelestium oblongum T. and A. SCOTT, British Parasitic Copepoda, 1913, p. 106, pl. 31, figs. 7–18; pl. 45, figs. 4–5.

Host and record of specimens.—So far as known this parasite, which is very common in Europe as well as America, has never been found upon any host except the common sturgeon, *Acipenser sturio.* This fish is found along our Atlantic coast from Canada to the Carolinas and from it have been obtained the following specimens in the collection of the National Museum:

Catalogue number.	Specimens.	Locality.	Collector.
6173	25 females	Noank, Long Island Sound.	Bureau Fisheries.
6174	8 females	do	Do.
6175	1 female, 1 male	do	Do.
6189	1 male	Woods Hole	V. N. Edwards.
8184	do	do	Do.
8186	3 females	England	
11615	6 females	Vineyard Sound	V. N. Edwards.
11616	1 female	do	Do.
12681	6 females, 2 males	Woods Hole	Do.
12682	2 females	do	Do.
12683	1 female, 2 males	do	Do.
34536	2 females	Long Island Sound	A. E. Verrill.
54074	8 females	Woods Hole	V. N. Edwards.
54075	10 females	do	Do.
54076	5 females	do	Do.

Remarks.—This genus is monotypic and the single species has been described and figured so many times that the genus diagnosis is sufficient for the present paper. It is unfortunate that the wrong specific

name has become so widely known that it will be difficult to make the requisite change. It is evidently cosmopolitan in distribution, being found everywhere that the host occurs. The common sturgeon is not only found in salt water, but it also runs up our rivers. Whether these parasites remain upon the gills after their host enters fresh water has not been determined, but they probably do. Strangely enough out of the long list of investigators who have recorded this parasite not a single one has mentioned that it was to be found in fresh water.

Genus CYBICOLA Bassett-Smith.

Helleria Bassett-Smith, Ann. Mag. Nat. Hist., ser. 7, vol. 1, 1898, p. 10.
Cybicola Bassett-Smith, Ann. Mag. Nat. Hist., ser. 7, vol. 2, 1898, p. 371.

Generic characters of female.—Body elongate, without dorsal plates. Head rounded, not fused with the first thorax segment, as wide as the genital segment. First three thorax segments free, each with a pair of soft lateral processes, the remainder of the body fused into an elongate genital segment, which carries the long and narrow anal laminae on its posterior margin. Egg strings longer than the body, straight.

First antennae seven-jointed, setaceous; second pair in the form of strong claws with a single tooth on their inner margin. First maxillae three-jointed, uncinate; second pair also three-jointed, tipped with a short, curved claw dentate on its inner margin. Maxillipeds two-jointed, the basal joint very large and powerful, its outer margin undulate and fringed with bunches of fine hairs, the terminal claw stout, strongly curved, with a single tooth on its inner margin. Three pairs of rudimentary swimming legs, the first pair biramose, the other two uniramose, all the rami minute, one-jointed, tipped with a seta.

Generic characters of male.—Body shorter than in the female, head more oval. No free thorax segments, but the entire thorax fused with the genital segment; abdomen distinct with foliate anal laminae whose tips are fringed with fine hairs. Antennae and mouth parts like those of the female except that the maxillipeds are longer and less stout. Only two pairs of swimming legs, the first pair biramose, the rami broad, one-jointed and tipped with claws, the second pair uniramose, the rami two-jointed and also tipped with claws.

Type of the genus.—*Cybicola armata*, monotypic.

Remarks.—This genus was first named *Helleria*, but as that name was already in use for a genus of crustaceans Bassett-Smith himself changed it later in the same year. It has never been seen or mentioned by any other scientist. Its principal characteristics are the absence of the third and fourth swimming legs in the male and of the

fourth legs in the female, the fusion of the entire thorax with the genital segment in the male and the soft lateral processes on the sides of the free thorax segments in the female.

Genus VENTRICULINA Bassett-Smith.

Ventriculina Bassett-Smith, Proc. Zool. Soc. London, vol. 1, 1903, p. 106, text fig. 12.

Generic characters of female.—Head fused with the first thorax segment; second, third, and fourth segments free, fifth and genital segments fused, but the fusion indicated by marginal incisions. Abdomen two-jointed with filiform anal laminae. Egg cases long and coiled, eggs uniseriate and well flattened. First antennae four-jointed, nonsetose; second pair three-jointed, setose but not uncinate; maxillipeds armed with stout prehensile claws. First legs biramose, rami two-jointed; second and third legs uniramose, rami one-jointed; fourth and fifth legs lacking. Male unknown.

Type of the genus.—*Ventriculina crosslandi*, monotypic.

Remarks.—Like the preceding genus this one has never been seen or mentioned by any investigator except Bassett-Smith. Its chief characteristics are the lack of the posterior swimming legs, the uniform diameter of the thorax, and the fact that the second antennae are nonprehensile. Bassett-Smith's statement given above, that the abdomen is two-jointed is open to doubt, and the coiling of the egg tubes might well have been the result of placing the specimens in alcohol.

It is worthy of note that the host is not a fish but a sipunculid from the coast of Zanzibar.

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EXPLANATION OF THE PLATES.

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Fig. 1, dorsal view of the male of *Anthosoma crassum;* fig. 2, dorsal view of the female, after T. and A. Scott, showing how the entire body is concealed by the dorsal plates of the head and thorax; fig. 3, first antenna of male; fig. 4, second antenna of male, side view; fig. 5, first maxilla, with palp; fig. 6, second maxilla; fig. 7, first swimming leg; fig. 8, second swimming leg; fig. 9, dorsal view of the female of *Lernanthropus caudatus;* fig. 10, first swimming leg of same; fig. 11, second swimming leg.

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Fig. 28, dorsal view of the female of *Lernanthropus leidyi;* fig. 29, side view of same; fig. 30, dorsal view of male of same; fig. 31, first antenna of female of *Lernanthropus chlamydotus;* fig. 32, second antenna of same; fig. 33, mouth tube and first maxillae; fig. 34, second maxilla; fig. 35, maxilliped.

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Plate 7.

Fig. 49, first legs of female of *Lernanthropus paenulatus;* fig. 50, second leg of same; fig. 51, dorsal view of male of *Lernanthropus brevoortiae;* fig. 52 second

antenna of same; fig. 53, maxilliped; fig. 54, second maxilla; fig. 55, first leg; fig. 56, second leg of male of *L. paenulatus*; fig. 57, nauplius of *Lernanthropus brevoortiae.*

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PLATE 10.

Fig. 70, dorsal view of female of *Nemesis atlantica;* fig. 71, longitudinal section on the midline; *cg*, cement gland; *oe*, esophagus; *ov*, ovary; *sr*, semen receptacle; *vd*, ventral nerve cord; fig. 72, first antenna; fig. 73, second maxilla; fig. 74, genital segment of male, ventral view; fig. 75, mouth tube and first maxillae of *Lernanthropus brevoortiae*, male.

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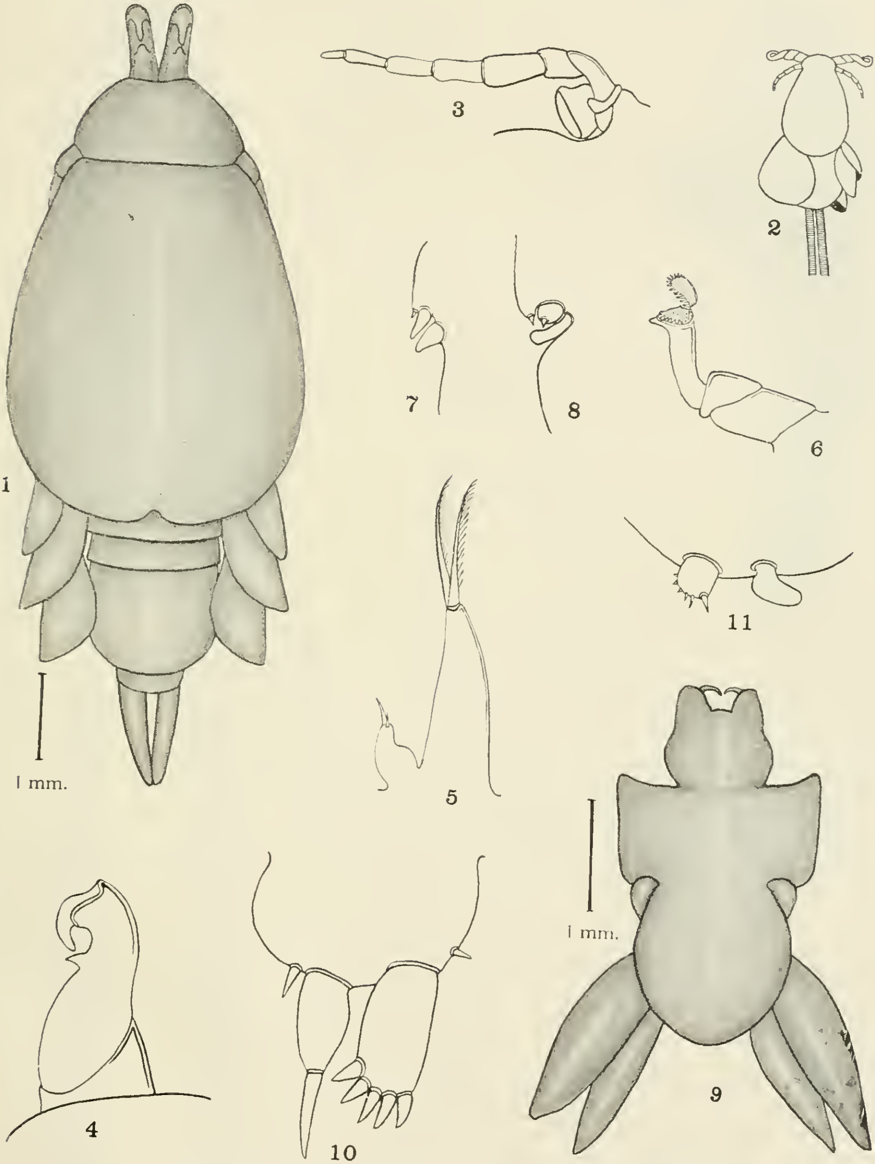
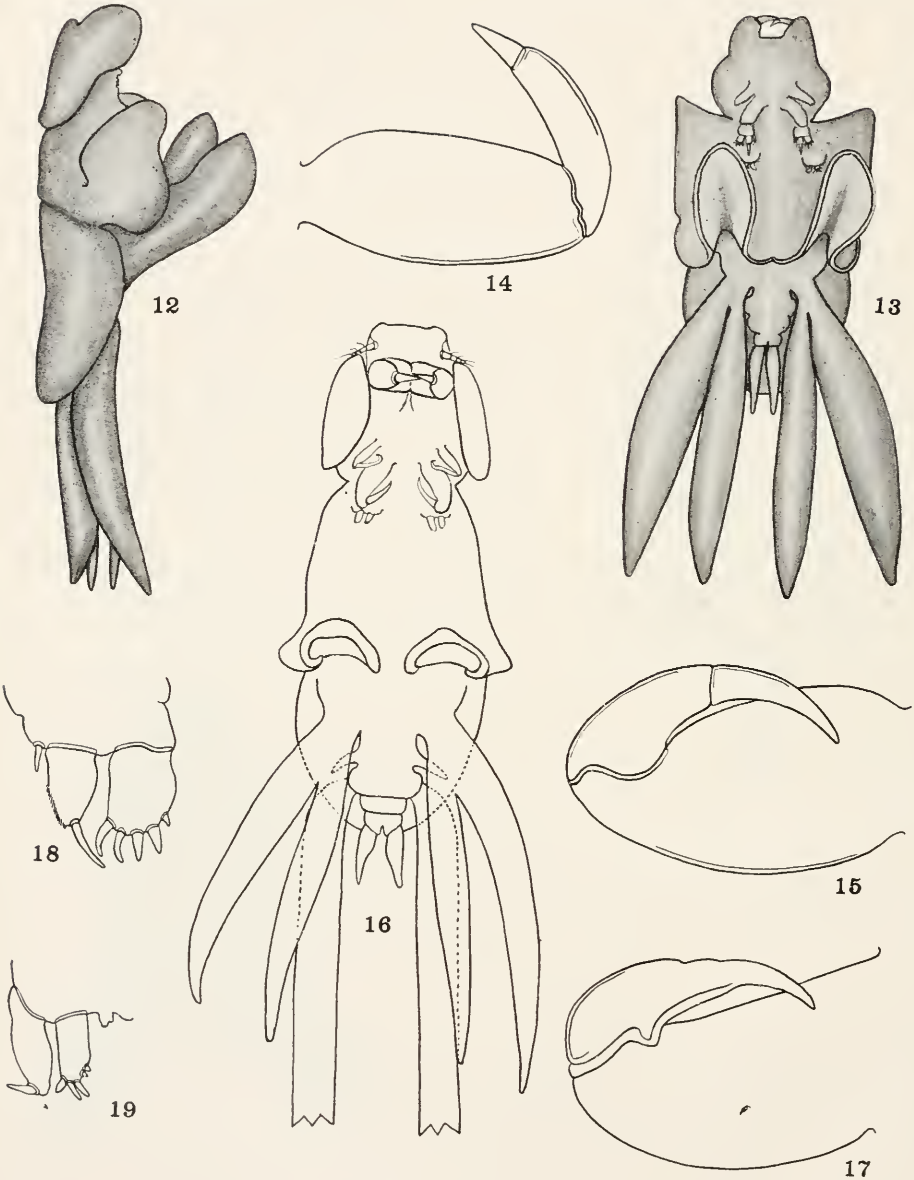
PLATE 13.

Fig. 101, dorsal view of female of *Pseudocycnus buccatus;* fig. 102, ventral view of another specimen without egg strings; fig. 103, nauplius; fig. 104, dorsal view of genital segment of female *Lernanthropus chlamydotus*, showing large spermatophores in position at the openings of the oviducts; fig. 105, cross section of the skin and underlying tissues in *Dichelesthium oblongum.*



ANTHOSOMA CRASSUM AND LERNANTHROPUS CAUDATUS.

FOR EXPLANATION OF PLATE SEE PAGE 97.



FEMALES OF LERNANTHROPUS CAUDATUS AND L. RATHBUNI.

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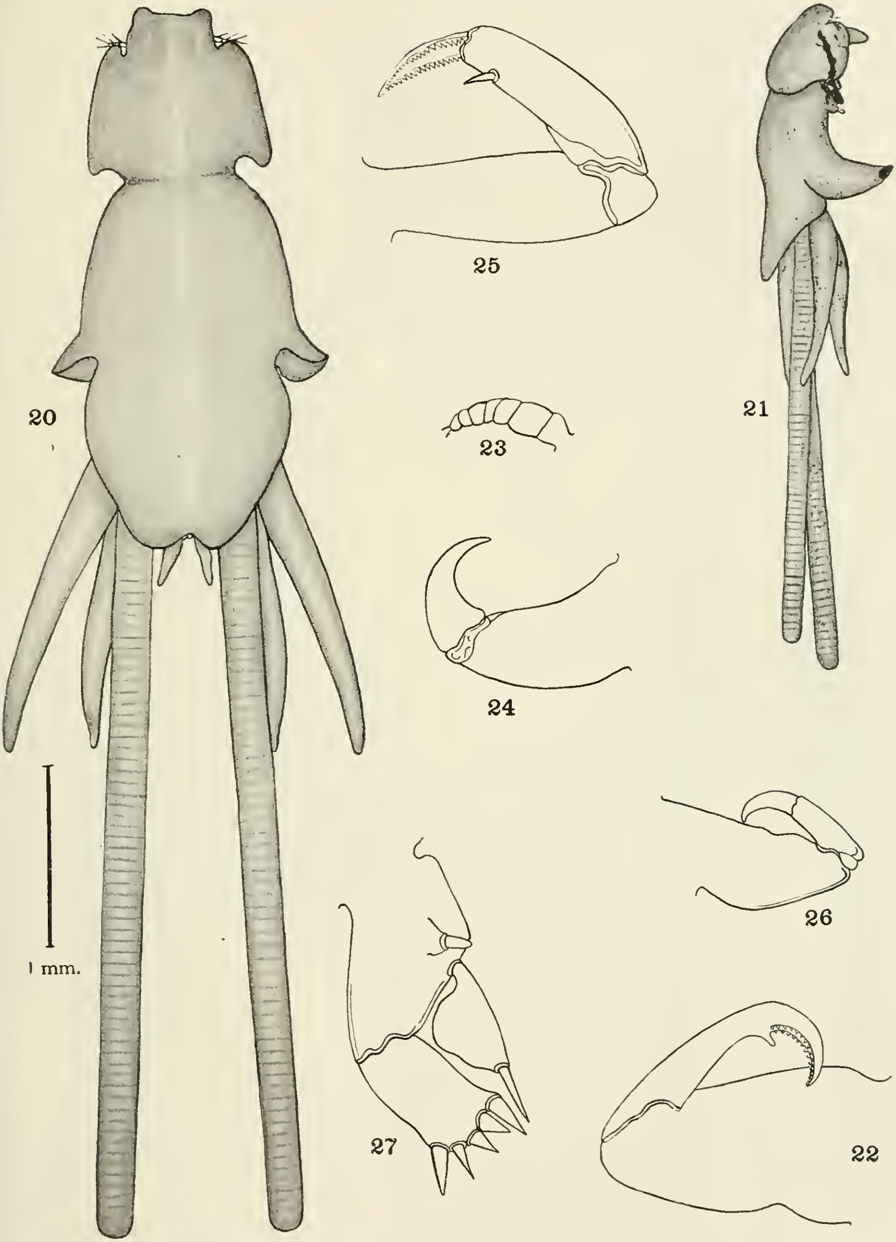

LERNANTHROPUS RATHBUNI AND L. LEIDYI.

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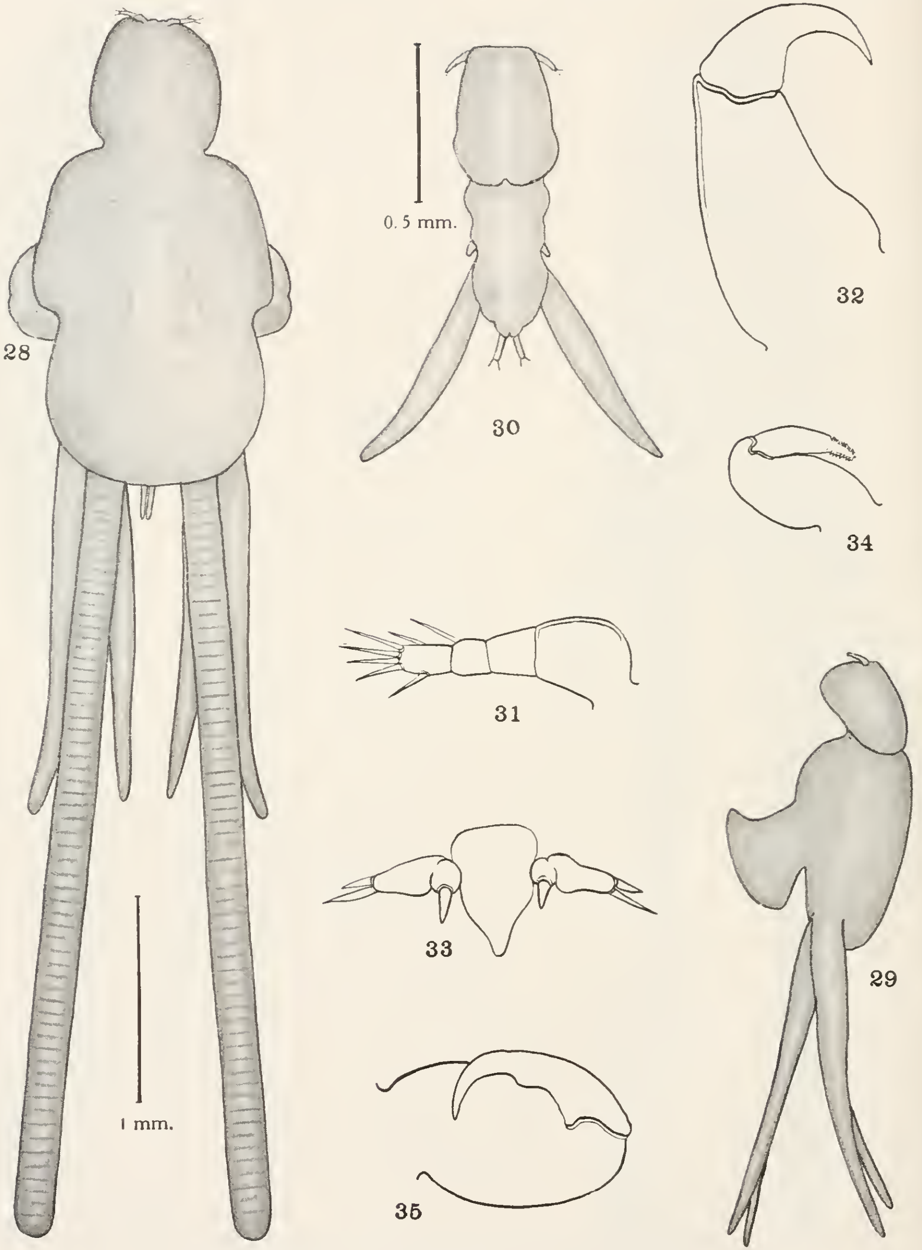

FEMALES OF LERNANTHROPUS LEIDYI AND L. CHLAMYDOTUS.

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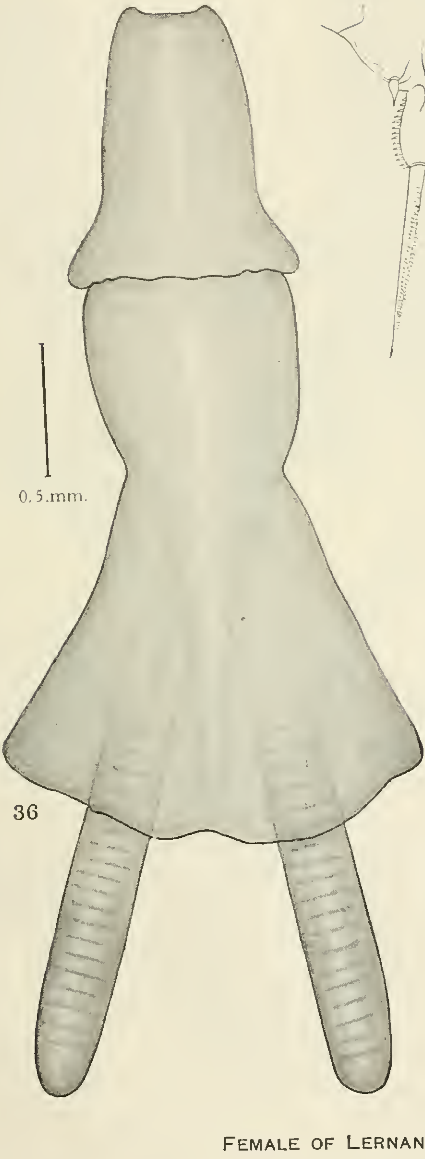

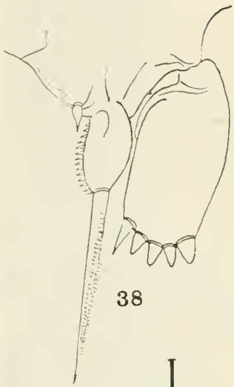

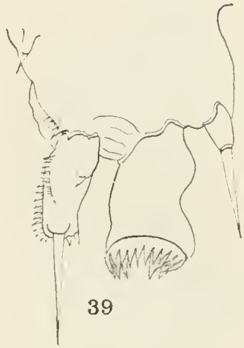

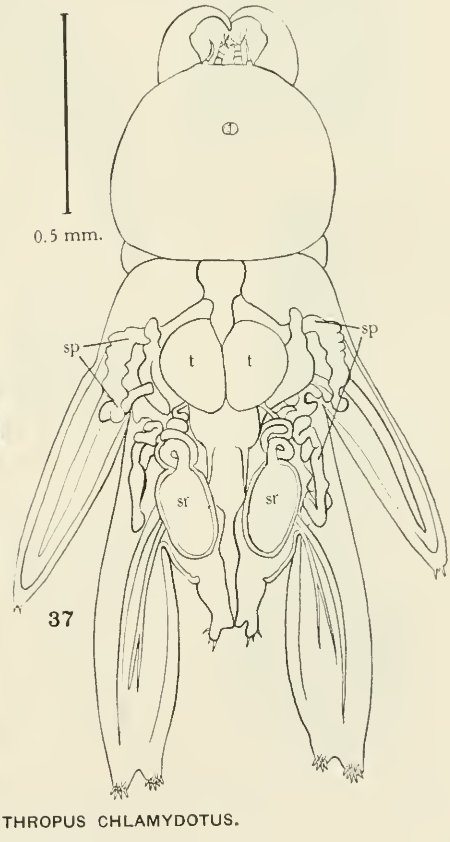

FEMALE OF LERNANTHROPUS CHLAMYDOTUS.

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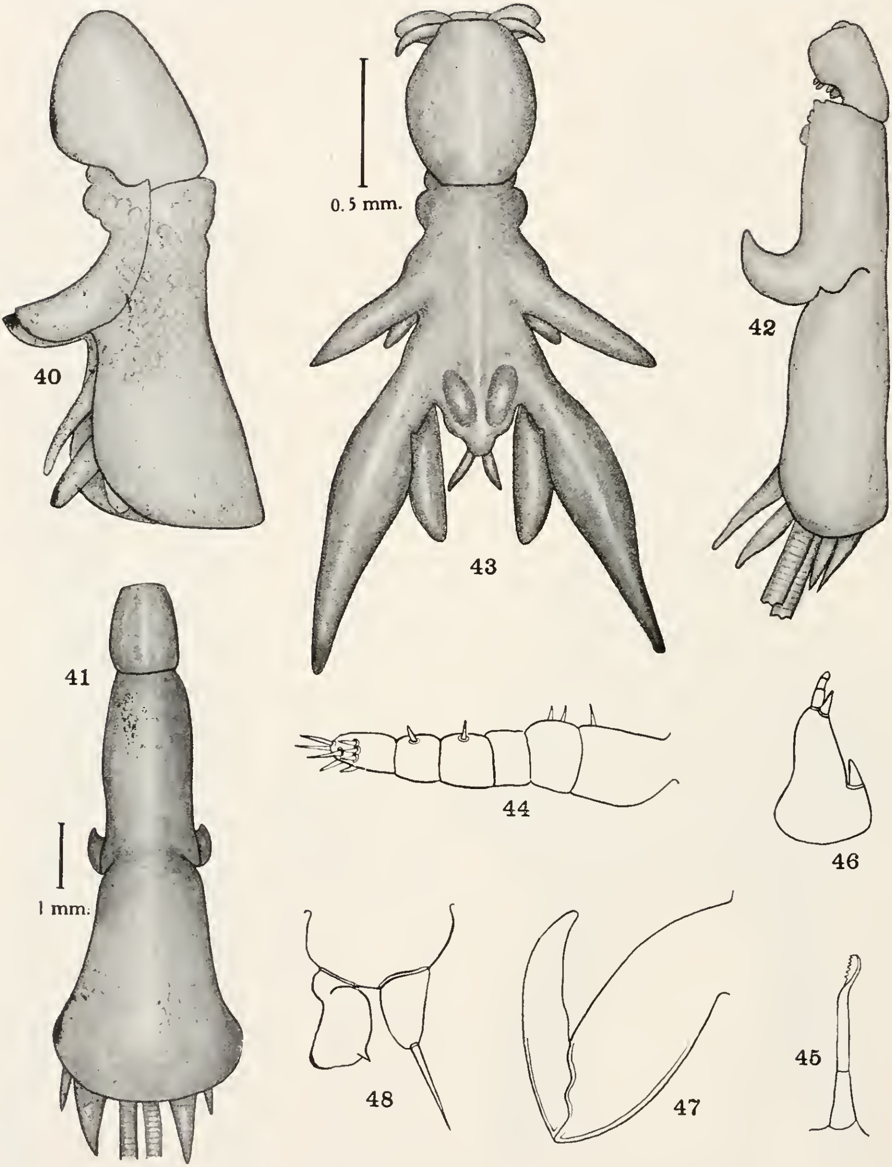

LERNANTHROPUS CHLAMYDOTUS AND L. PAENULATUS.

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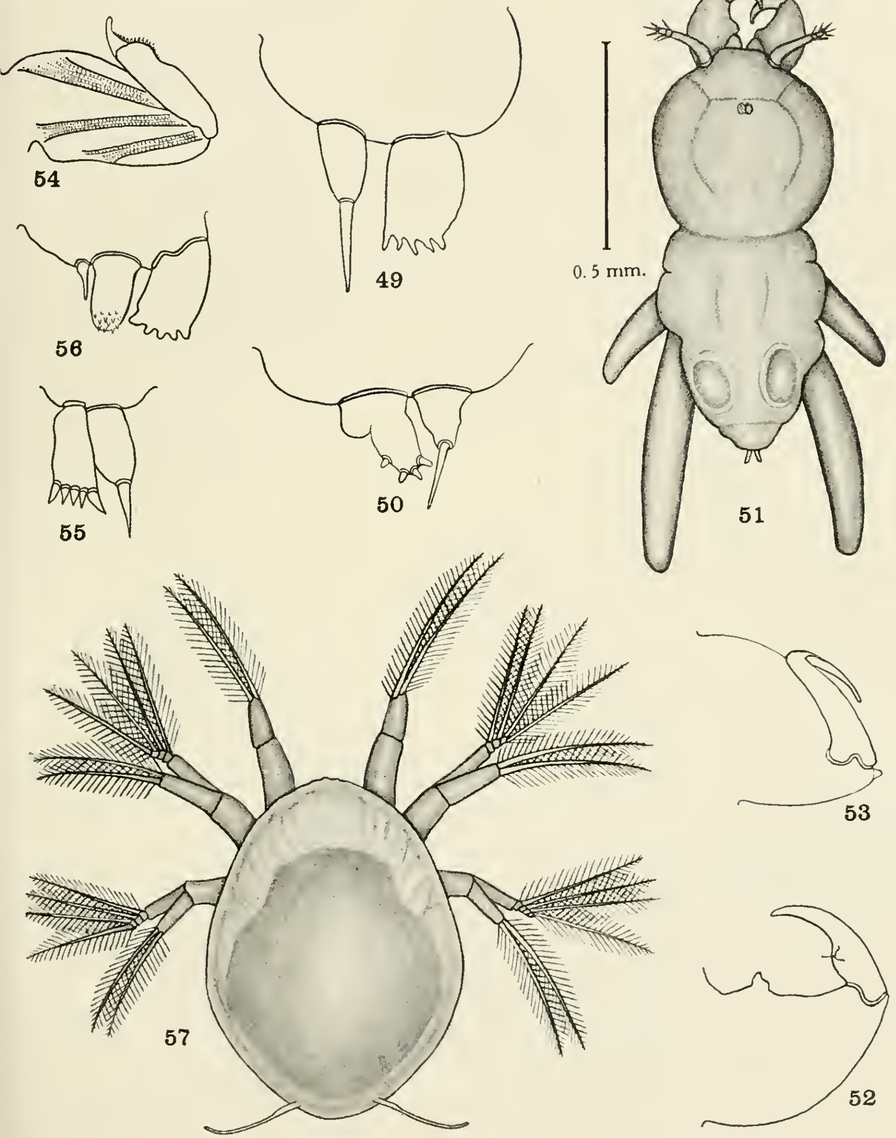

LERNANTHROPUS PAENULATUS AND L. BREVOORTIAE.

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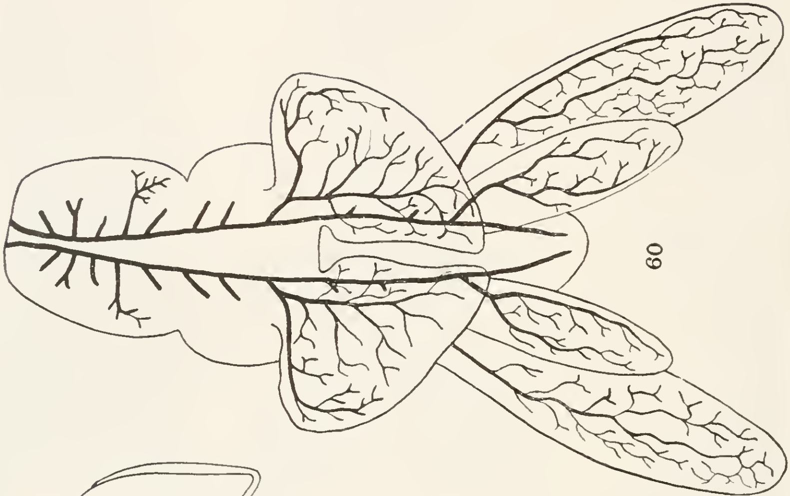

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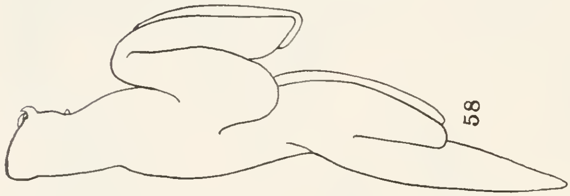

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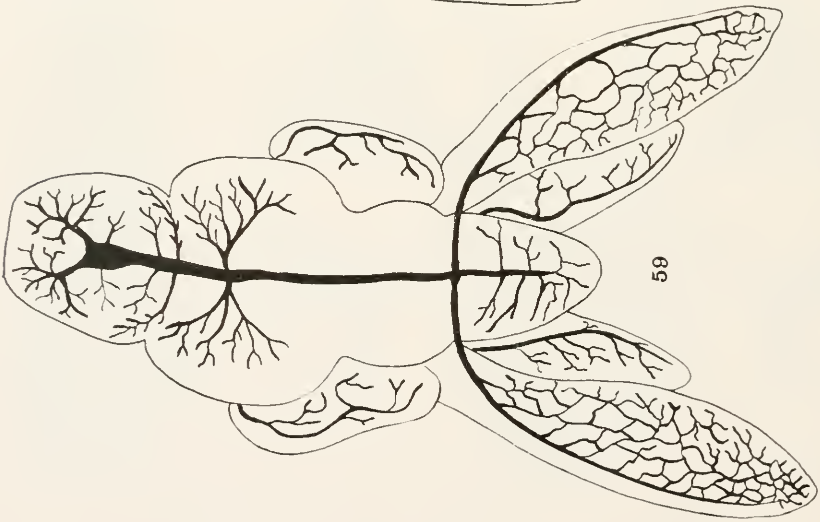

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FEMALE OF LERNANTHROPUS BREVOORTIAE.

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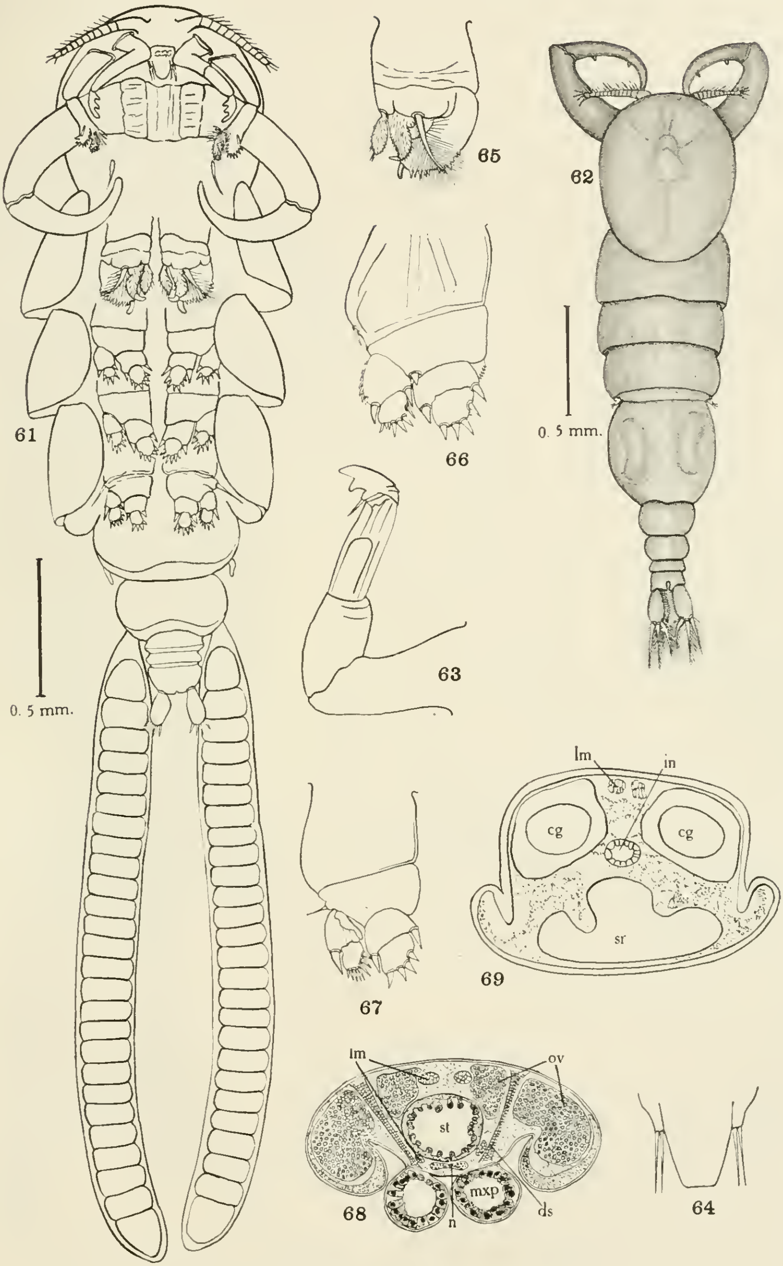

FEMALE OF NEMESIS ATLANTICA.

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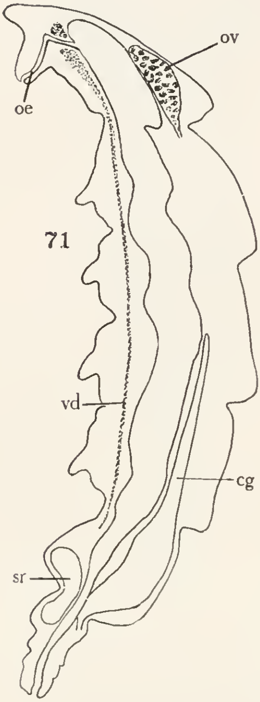

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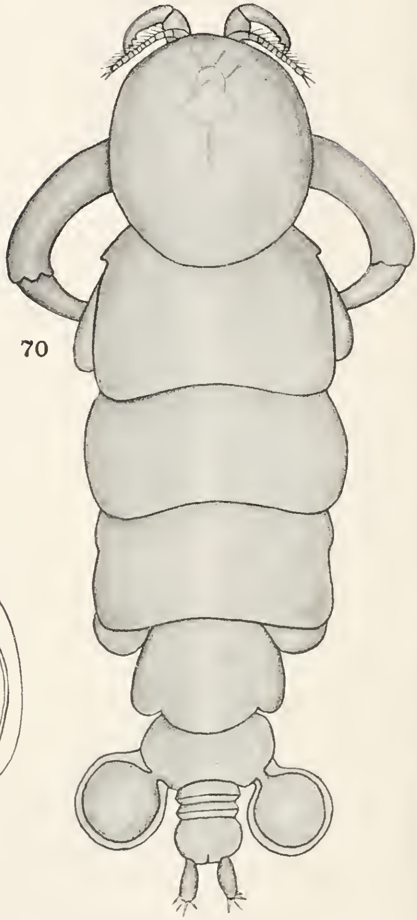

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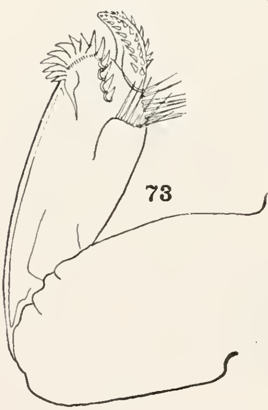

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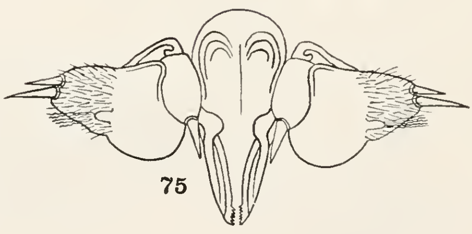

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FEMALE OF NEMESIS ATLANTICA AND MALE OF LERNANTHROPUS BREVOORTIAE.

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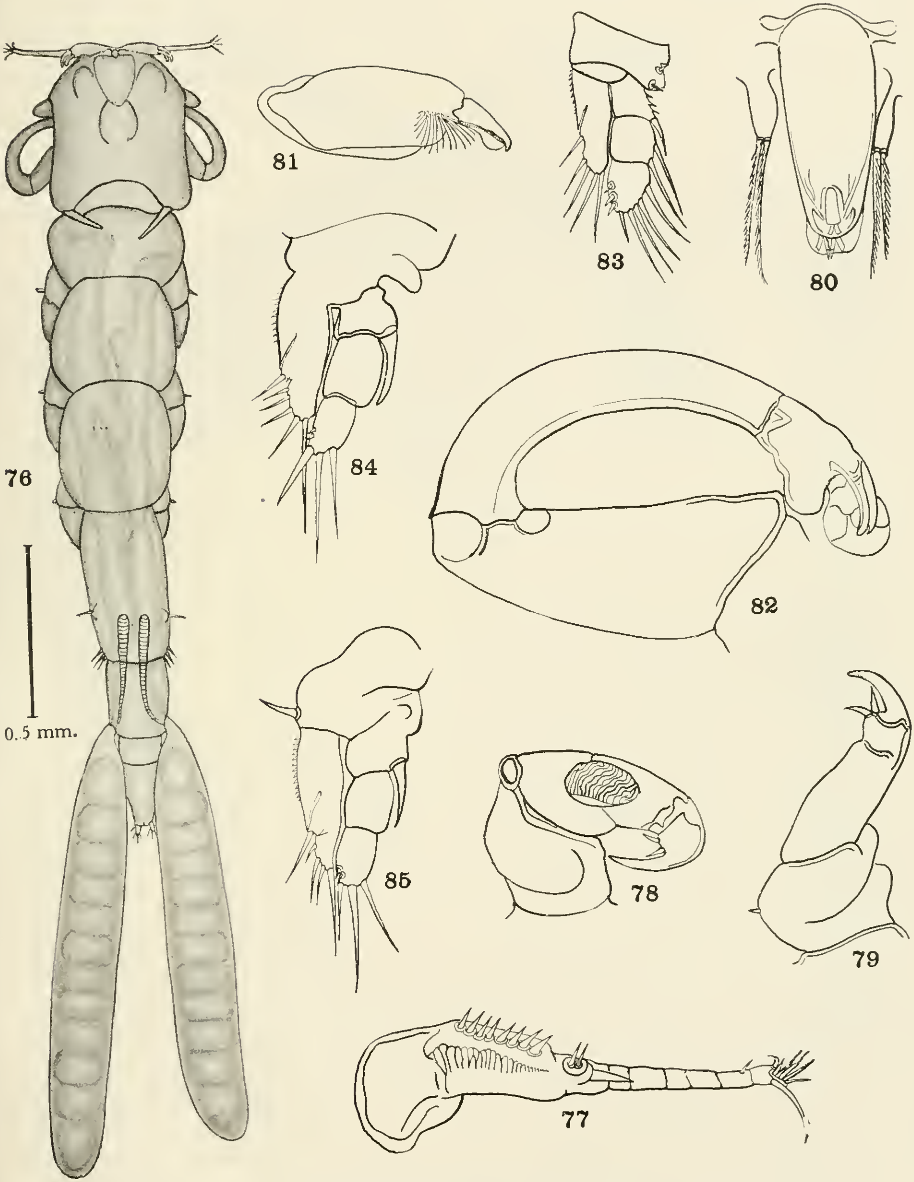

FEMALE OF EUDACTYLINA NIGRA.

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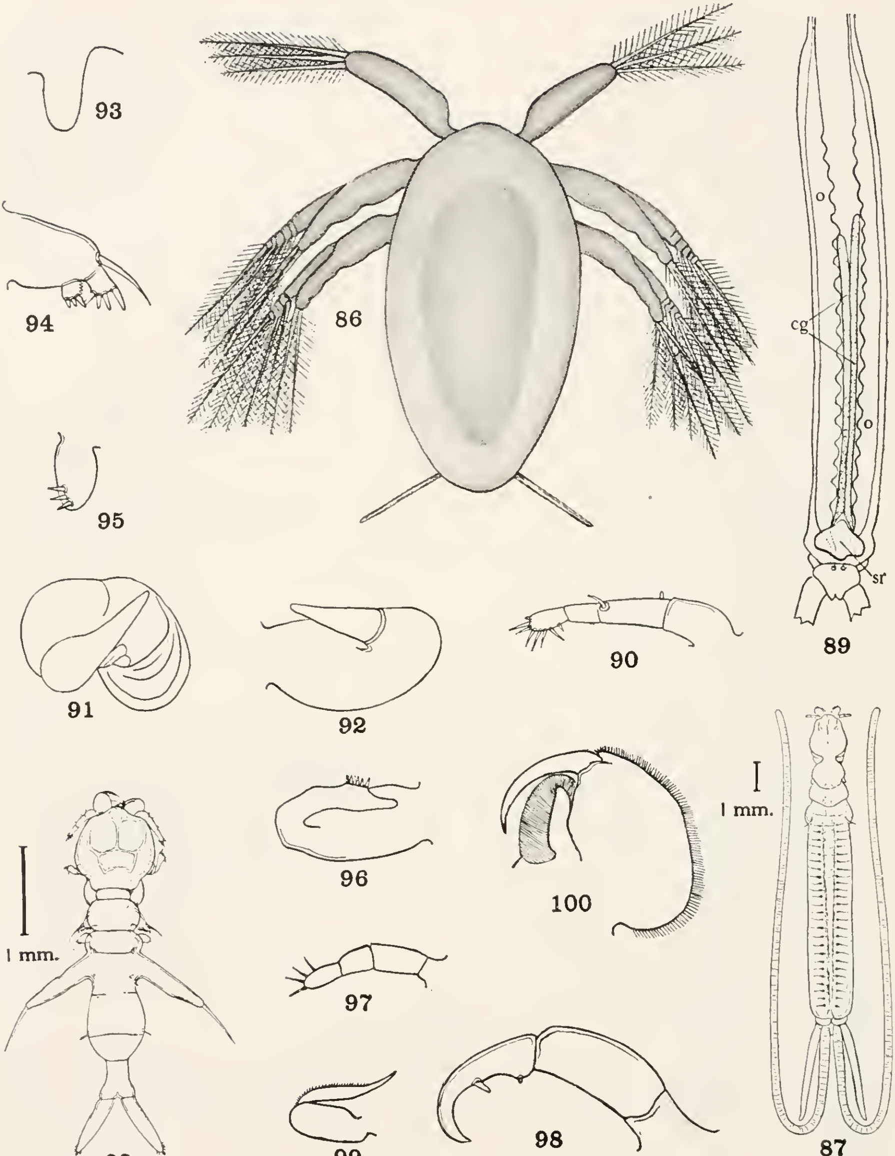

EUDACTYLINA NIGRA, PSEUDOCYCNUS APPENDICULATUS, AND P. BUCCATUS.

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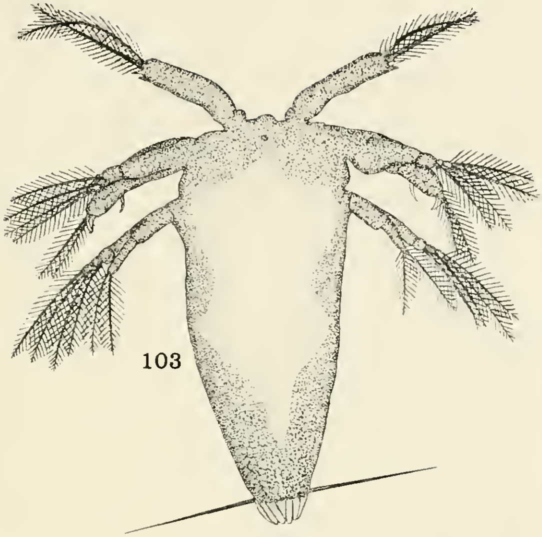

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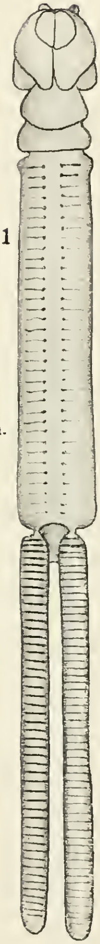

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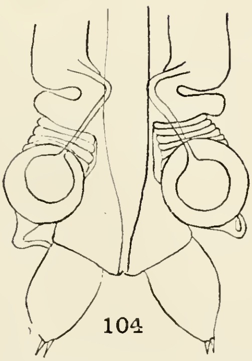

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PSEUDOCYCNUS BUCCATUS, LERNANTHROPUS CHLAMYDOTUS, AND DICHELESTHIUM OBLONGUM.

FOR EXPLANATION OF PLATE SEE PAGE 98

INDEX.

A CONTRIBUTION TO THE ANATOMY OF DINOBOTHRIUM, A GENUS OF SELACHIAN TAPEWORMS; WITH DESCRIPTIONS OF TWO NEW SPECIES.

By Edwin Linton,
Of the University of Missouri, Columbia, Missouri.

In 1889 P. J. van Beneden described an interesting cestode from the mackerel shark (*Lamna cornubica*) under the name *Dinobothrium septaria*.[1]

The species has been recorded from the same host by Loennberg[2] and by Scott.[3] Loennberg gives detailed description of the scolex and of immature proglottides. Scott publishes a brief description of the species and a protograph of a specimen collected by him.

Strobiles with adult, or ripe, proglottides were not seen by any of the above-named authorities.

I am indebted to Dr. Maurice C. Hall, of the Zoological Division of the United States Department of Agriculture, for photographic copies of Loennberg's papers.

This paper is a contribution from the laboratory of the United States Bureau of Fisheries, Woods Hole, Massachusetts, and the zoological laboratory of the University of Missouri.

On September 1, 1903, I collected some cestodes from a small maneater shark, of which no description was published, but a record was made,[4] as follows:

Dinobothrium septaria Beneden. Host: *Carcharodon carcharias* Linton, MS

A typographical error appears in the spelling of the generic name, which is printed "*Dinabothrium.*"

During the summer of 1920 I obtained three specimens of a cestode from the bone shark, which also belong to the genus *Dinobothrium*. Although at first disposed to refer the cestodes of these two lots to the species *D. septaria*, I found difficulties of two sorts present-

[1] Bull. Acad. roy. d. Belg., vol. 17, pp. 68–74, figs. 1–3.

[2] Zwei Parasiten aus Walfischen und zwei aus Lamna cornubica. K. vet. Akad. Handl., Stockholm, vol. 24, 1898, pp. 25–28, figs. 11 and 12. Ueber einige Cestoden aus dem Museum zu Bergen, 1898, pp. 19–23, fig. 10.

[3] Twenty-sixth Ann. Rep. Fisheries Board of Scotland, pt. 2, p. 84, fig. 4, 1898.

[4] Bull. Bur. Fish. (1911), vol. 31, pt. 2, p. 586.

ing themselves. In the first place the worms of each lot differ slightly but constantly from the figures and description of *D. septaria.* In the second place, when the scoleces of the two lots were compared one with the other they were found to be unlike in many details.

The scoleces of the worms from the bone shark have long strobiles with ripe proglottides attached to them, while those from the man-eater shark are smaller and have short strobiles with only immature proglottides. Consequently one must rely very largely on the scoleces in a comparative study of the two forms.

It should be noted that we are here dealing with cestodes from selachians, which are generically different from each other, and generically different from the host of *D. septaria.* Further, the species *D. plicitum,* whose scolex appears to differ rather more from *D. septaria* than does *D. planum,* is from a host which belongs to the same family as *Lamia,* that is the Lamnidae, or mackerel sharks. On the other hand, *D. planum,* whose scolex resembles *D. septaria* rather more closely than does *D. plicitum,* is from a host which belongs to the family Cetorhinidae, or basking sharks.

The following adaptation from Beneden's description of *D. septaria* is in agreement with the forms from *Carcharodon* and *Cetorhinus* and may be taken, therefore, as characters of the genus *Dinobothrium:* Bothria four, in pairs placed back to back, without hooks, large, oval, attached the entire breadth of the base, the external face concave, and surmounted above by a projection. Above each bothrium there is a little sucker, and outside the sucker the part which supports the lobe is terminated by a short appendage.

Regarding the cestodes, which furnished the basis of this report as new species, the genus *Dinobothrium* is represented by the following species:

Dinobothrium septaria Beneden. Hosts: *Lamna cornubica.*
Dinobothrium plicitum, new species. Hosts: *Carcharodon carcharias.*
Dinobothrium planum, new species. Host: *Cetorhinus maximus.*

DINOBOTHRIUM PLICITUM, new species.

Figures 1, 4, 5, 6.

Dinobothrium septaria BENEDEN, Linton, Bull. Bur. Fish. (1911), vol. 31, pt. 2, p. 586.

Type.—Cat. No. 7601, U.S.N.M.

The material upon which this description is based was collected from the spiral valve of a small man-eater shark, 4 feet in length, at Woods Hole, Massachusetts, September 1, 1903. The contents of the stomach consisted of fish and squid.

The following are extracts from notes made at the time of collecting:

Bothria four, in pairs corresponding in position with the flat sides of the strobile, and acting as cupping disks. The mucous membrane, upon removal of the worms, was congested, the capillaries showing plainly in four spots where the bothria had been applied. The scoleces changed shape but little when placed in killing fluid. There are small suckers at the anterior ends of the bothria unlike any that I have seen before in selachian cestodes. Strobiles evidently all immature, much contracted, with a tendency to twist and crumple, and difficult to straighten. Ten scoleces were found in the spiral valve of this shark. Associated with them were 50 or more cestodes belonging to the genus *Phyllobothrium*.

No measurements of the strobiles are given in my notes. The longest alcoholic specimen measures about 20 mm. in length.

Scolex.—Details of the structure of the scolex are shown in figure 1, the outlines of which are from a specimen mounted in balsam. A front view of the scolex is shown, and at the same time a full-face view of the bothria. Specimens in alcohol do not differ materially from the sketch, except in the more or less cup-like character of the bothria. In most cases the bothria flare widely so as to look forward, a line normal to their surface making an angle of from 30 to 45 degrees with the axis of the scolex. In all cases the bothria have thin edges and present a characteristically clean-cut appearance. The bothria are dorso-ventrally placed, that is, corresponding with the flat sides of the strobile. The anterior end of the scolex is flat, and, in dorso-ventral view, makes a straight line at right angles with the axis of the scolex. A single bothrium has the following characters: The general shape is like that of a deep scoop, becoming in some cases cup-like. The outer, or lateral, border is convex; the inner, or median, which lies close to the inner border of its mate, is straightish. At the middle of the posterior free border there is a short groove, each of the sides of which rises into a short, almost papillary, projection. The anterior end is thick at the back, where it is continuous from one bothrium to the other of the same pair, and is reflected in a double, shelf-like projection, each portion of which terminates in a pointed tip at the median border. Toward the lateral border the two shelves blend and continue in a curved fold which is bifurcate at the tip. The outer or anterior portion of the projection is thickish and forms a sucker-like depression. The inner portion of the projection is thin edged. The pointed tips appear to be rigid and almost hook-like (fig. 4). Sections of the bothria (fig. 5) show that they are made up, for the most part, of short, thick muscular fibers at right angles to the flat surfaces.

A striking feature of the bothria of this species is the furrow at the middle of the posterior border. This is not an accidental contraction character, but is present in each bothrium in each of the

scoleces of the lot, and is a conspicuous feature which imparts a characteristic accentuation to the outline of all the bothria.

Dimensions of bothria: Length, maximum 4 mm., minimum 2.5 mm.; breadth, maximum 2.5 mm., minimum 1.5 mm. Breadth of scolex in front, maximum 2.5 mm., minimum 2 mm.

Each bothrium is united with its fellow below the free median borders; each is also continuous below with the corresponding bothrium of the opposite pair.

The scolex possesses a very short neck-like portion which ends abruptly, in some cases projecting a little, at the point of junction with the strobile. A transverse section of a scolex is shown in figure 5*A*. Excretory vessels and a few ganglion cells appear in the parenchyma, and the characteristic musculature of the bothria is represented.

A portion of a bothrium, more highly magnified, is shown in figure 5*B*. The ganglion cells in the muscle tissue of the bothria are large, branching, and suggest a multipolar structure.

Loennberg[5] notes the occurrence of such cells in *D. septaria*. He describes them as being of peculiar structure, their cytoplasm coarsely fibrous and without distinct borders. Each cell has a vesicular nucleus, which contains a very small but sharply defined nucleolus.

The ganglion cells in *D. plicitum* agree with Loennberg's description, except that the cytoplasm, instead of appearing to be coarsely fibrous, is rather reticulate; that is, it has somewhat the appearance of an ameba with anastomosing pseudopodia.

Strobile.—The segments begin immediately behind the scolex, the strobile here, and throughout, being relatively flat and thin. In the specimen, from which the sketch for figure 1 was made, the strobile near the scolex measured 1.12 mm. in breadth, and the proglottides are 0.14 mm. in length.

Figure 6 represents a transverse section made at a point where the strobile measures 1.20 mm. in breadth. The excretory vessels and the lateral nerves are shown. The musculature is rather weak, longitudinal fibers being the only ones that could be made out, and the muscular layer is not sharpy marked off from the subcuticula. Indeed, under high magnification sections of fine longitudinal muscle fibers appear close to the cuticula. The smaller dorsal excretory vessel lies in a rather close spiral and is often cut in two or three places in the same section. The larger vessel also is spiral, but with looser coils than the smaller vessel.

The strobiles in this lot were all immature. The greatest breadth noted was 1.33 mm., at which point the proglottides averaged 0.25 mm. in length. The strobile appears to have a shallow furrow run-

[5] K. vet. Akad. Handl. Stockholm, vol. 24, 1898, p. 25, fig. 12.

ning along the median region of one side. The margins are finely crenulated.

DINOBOTHRIUM PLANUM, new species.

Figures 2, 3, 7–13.

Type.—Cat. No. 7602, U.S.N.M.

On June 24, 1920, a bone shark (*Cetorhinus maximus*) was captured in the inlet at Menemsha Bight, island of Martha's Vineyard, Massachusetts. Mr. George M. Gray, of the Marine Biological Laboratory, Woods Hole, Massachusetts, examined the shark for parasites and reports that he found but one species of entozoon parasite. a cestode represented by a few specimens in the spiral valve. Three of these worms were given to me by Mr. Gray, with the information that the length of the shark was 25 feet, and that the only identifiable food which he found was the test of a large species of *Salpa*. In the stomach was "about a half a barrel of red-colored material which looked like tomato ketchup."

My note made after a preliminary examination of the material is as follows:

Lengths in alcohol, 145, 440, and 545 mm.; breadth of scolex of largest specimen, 10 mm.; thickness, 5 mm.; length, 8 mm. This specimen had been preserved in formalin, and was less contracted than the others, which had been fixed in corrosive sublimate. Strobile linear with a shallow furrow along the median line of one of the flat sides. There is a tendency to develop fine longitudinal furrows, which, with the short segments, impart a somewhat checkered appearance to the surface in many parts of the strobile. Breadth immediately behind the scolex, 2 mm.: at posterior end and maximum, 4 mm. The proglottides begin immediately behind the scolex where their length is about 0.4 mm. They remain relatively short throughout the length of the strobile. A piece of strobile from the posterior end, and 15 mm. in length, is made up of 21 proglottides, which are filled with eggs. These proglottides are 4 mm. in breadth and 0.7 mm. in length. The proglottides are distinct throughout, with more or less convex outlines on the margins: genital apertures irregularly alternate and at about the middle or a little anterior to the middle of the length of a proglottis.

Mr. Gray has recently sent me the following additional data:

He has eight specimens with scoleces and one without. Their lengths in millimeters are: 81, 227, 262, 387, 487, 687, and 825, respectively. These were the only internal parasites found. A number of parasitic copepods were obtained.

The shark is being mounted for the Boston Society of Natural History.

Scolex.—Details of structure are shown in figures 2 and 3. The bothria are large and flat, and have thick, entire margins. The anterior edge is not reflected, and is even but slightly projecting. The median margins of a pair fuse together near the anterior ends. In front view the suckers are prominent, the anterior shelf-like projection being represented only by the thickened semicircular border of a sucker. There is lacking the groove at the posterior edge of the bothria and the pseudo-hooklets at the angles. In one of the specimens the outline of the anterior end is elevated in the middle on account of raised median angles of the bothria. This seems to be a contraction character, as in the other two specimens the front ends are flat and practically at right angles to the axis of the scolex.

The breadth of each of the three scoleces in front is 6.5 mm., and the thickness of each is 4 mm. In one the breadth of a bothrium is 3 mm. and the length 7 mm.; in another the breadth is 4 mm. and the length 7 mm.; in the third the breadth is 5 mm. and the length 9 mm. In each of these three scoleces the bothria are nearly parallel with the axis of the scolex, and all are rather shallow and plate-like. This is in contrast with the prevailing cup-like character and widely flaring position of the bothria in *D. plicitum.*

Strobile.—The superficial characters of the strobile have already been described. The most outstanding features are the relative shortness of the proglottides, the linear habit of the strobile, and the development of longitudinal furrows, the most conspicuous being a median furrow on one of the flat surfaces (ventral), especially noticeable in the anterior region. Transverse sections made through unripe sections show a striking waist-like constriction at about the middle, indicating a median furrow on both the dorsal and ventral sides. The shortness of the proglottides as compared with the breadth persist even to ripe ones filled with eggs, which are still only from one-tenth to one-sixth as long as they are broad. This is in marked contrast with Beneden's figure of *D. septaria,* in which the proglottides are represented as becoming squarish, and even longer than broad, toward the end of the strobile.

Anatomy of proglottis.—The different layers of the wall are not sharply marked off from each other. The cuticle in adult segments is thin. The limits between the subcuticula and the layer of longitudinal muscle fibers is not clearly defined, but in a series of sections stained in indigo-carmine, in which the muscles came out a bright blue, and the granular bodies in the subcuticula appeared as red dots on a pale blue field, the two layers were fairly well differentiated. It was noticed that the subcuticula at one region of the sections contained numerous relatively large glandular bodies which lay immediately under the cuticula (figs. 8 and 10 *scg.*). An examination of series of sections, both transverse and sagittal, revealed the interest-

ing fact that this localization of subcuticular glands is limited to the posterior half, or two-thirds, of the right side of the ventral surface of the proglottides. The fibers of the longitudinal muscles are fine and arranged in fascicles.

In a section of a mature proglottis, at a point where the thickness was 0.44 mm., the thickness of the subcuticula was 0.08 mm., and that of the layer of longitudinal muscle fibers 0.06. It should be said in this connection, however, that there is considerable variation in the ratios even of measurements made at different points on the same section.

No layer of circular muscles could be distinguished in any of the sections, so that all the space within the layer of longitudinal muscles is occupied by parenchyma in the immature segments, by the reproductive organs in mature, and by remnants of reproductive organs and eggs in ripe proglottides.

The ventral excretory vessels are relatively large as seen in section, the dorsal are more variable on account of their more tortuous course.

Male reproductive organs.—The cirrus lies beside the vagina, in some cases a little below the level of the vagina, in others a little above. It is rather short, was not seen everted, is armed with straight, slender spines, measuring about 0.015 mm. in length. The cirrus-pouch is cylindrical, and its walls are rather thin. The vas deferens is voluminous, some of its folds lying beside the inner end of the cirrus-pouch, and extending to the median region of the proglottis. The testes are distributed on the dorsal side of the proglottis, from near the margins, and fill more than half of the parenchymatous space on either side of the medianly placed germarium. The voluminous folds of the vas deferens and those of the vagina and seminal receptacle lie close together towards the median portion of the proglottis.

Female reproductive organs.—The vagina lies beside the cirrus-pouch, and opens at the common genital pore, which is situated at about the middle, or a little in front of the middle, of the lateral margin of the proglottis. It lies, in the main, parallel with the cirrus-pouch, both being about at right angles to the margin of the proglottis. In some cases it is a little above the level of the middle of the cirrus-pouch, in others a little below that level. The walls of the vagina are thick and glandular. It is somewhat tortuous for a short distance in the neighborhood of the inner end of the cirrus-pouch, and again, as it approaches the median line, it is thrown into numerous capacious folds which constitute the seminal receptacle. At about the median line it turns abruptly towards the posterior, narrows to a slender tube, and enters the germ duct at a short distance back of the bulbous, thick-walled structure which marks the

beginning of that duct. The short germ duct is joined by the vitelline ducts as it enters the shell gland. It then turns in its course, so that, as the oviduct, it leaves the shell gland, it is near the point where the germ duct has its beginning. These structures form a compact mass and the sections through them are not easy to interpret.

The germarium occupies a little less than the middle third of the posterior portion of a mature proglottis in which but few eggs have accumulated in the uterus. Its antero-posterior diameter is equal to about two-thirds the length of the proglottis. At either side of the median line it fills all the space in a dorso-ventral direction within the layer of longitudinal muscles.

The shell-gland is situated on the median line near the posterior end of the proglottis, and is surrounded by the germarium. It is a compact gland made up of large, oval, or pyriform cells, deeply staining in haematoxylin. The diameter of the cells of the germarium was found to be 0 006 mm., while the cells of the shell-gland were 0.009 and 0.015 mm., in the two principal diameters.

The uterus in immature proglottides is represented by an elongated mass of cells lying on the ventral side along the median line (fig. 11). It comes to occupy more and more space as the proglottides mature, and in ripe proglottides practically all of the interior is filled with eggs. The eggs are very small and nearly circular in outline. They measure from 0.012 to 0.015 mm. in diameter.

The vitellaria are distributed along the ventral side of the proglottis next within the longitudinal muscle layer. In haematoxylin-stained sections they are not differentiated from the testes and germarium, but can be distinguished readily from the former by the smaller follicles, and from the latter by the irregular outlines of the cells, and, in mature proglottides, by the fragmented condition of many of the cells. In a section of a proglottis, in which eggs were beginning to appear, the diameter of the vitelline follicles was about 0.03 mm. while the diameter of the testicular follicles was 0.10 mm. In sections stained with indigo-carmine the vitellaria are well differentiated. Transverse sections show that the vitellaria take up much less of the thickness of the proglottis than do the testes, while their distribution laterally is about the same.

EXPLANATION OF PLATES.

The following letters have the same significance in all the figures:

c, cuticle.
cp, cirrus pouch.
ev, excretory vessel.
evd, dorsal excretory vessel.
evv, ventral excretory vessel.
ga, genital aperture.
gc, ganglion cells.
gd, germ duct.
lm, longitudinal muscles.
n, nerve.
o, ovary (germarium).
ov. oviduct.
sc, subcuticula.
scg, subcuticular glands.
sd, sperm duct.
sg, shell-gland.
sr, seminal receptacle.
t, testes.
u, uterus.
v, vagina.
vd, vas deferens.
vg, vitellaria.
yd, vitelline duct.

I am indebted to Mr. George T. Kline, biological artist, University of Missouri, for the sketches which accompany this paper.

PLATE 1.

FIG. 1. Scolex of *Dinobothrium plicitum*, from *Carcharodon carcharias*. Front view; outline from specimen mounted in balsam; details added from alcoholic specimens. Breadth of scolex in front 2.5 mm.

FIG. 2. *Dinobothrium planum*, from *Cetorhinus maximus*. Front view of scolex. Length of bothrium 7 mm.

FIG. 3. Scolex of *Dinobothrium planum*. Marginal view. Length of bothrium 7 mm.

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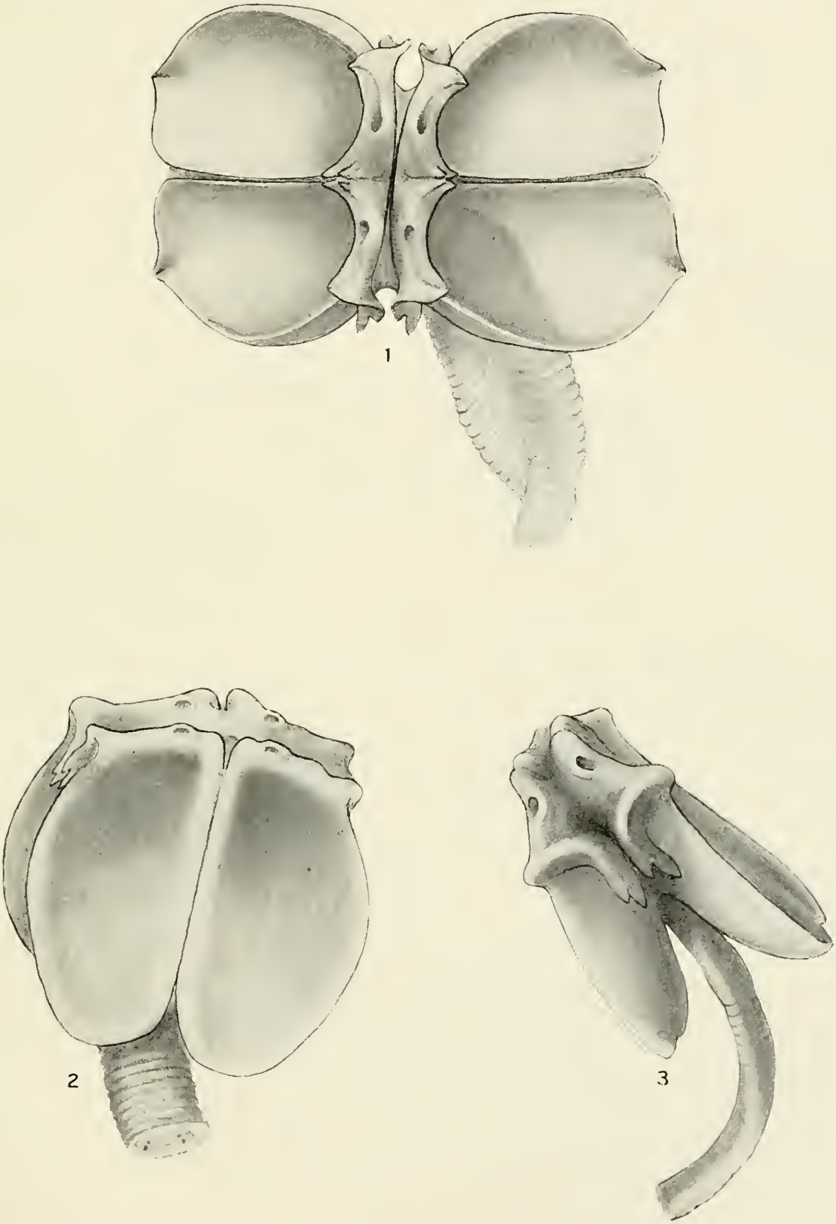
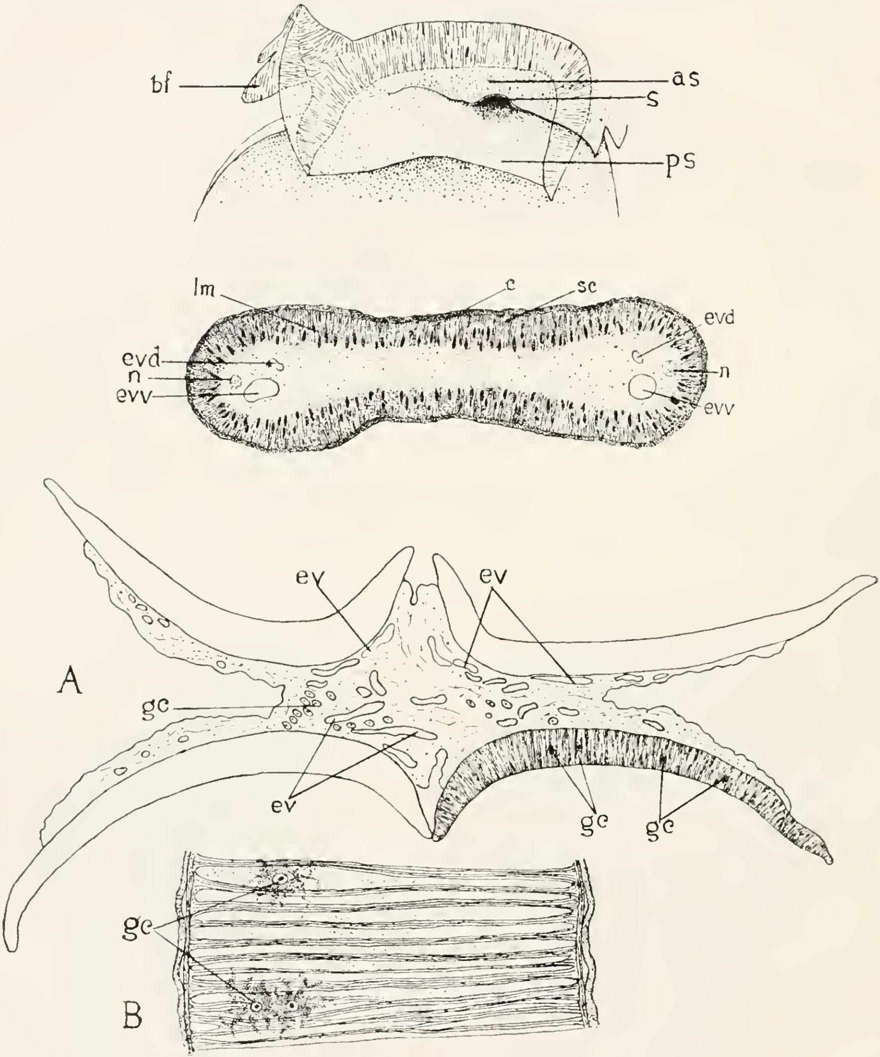


SCOLECES OF DINOBOTHRIUM PLICITUM AND D. PLANUM

FOR EXPLANATION OF PLATE SEE PAGE 10.



DINOBOTHRIUM PLICITUM FROM CARCHARODON CARCHARIAS

FOR EXPLANATION OF PLATE SEE PAGE 11.

PLATE 2.

FIG. 4. *Dinobothrium plicitum.* Anterior end of a bothrium, in balsam; breadth, 1.25 mm.; *as*, anterior shelf-like projection; *bf*, lateral appendage; *ps*, posterior shelf-like projection; *s*, auxiliary sucker.

FIG. 5. *Dinobithrium plicitum.*

A. Transverse section of scolex. Shorter diameter, 1.20 mm.

B. Transverse section of bothrium, more highly magnified, showing ganglion cells. Thickness of bothrium, 0.18 mm.

For explanation of lettering see p. 9.

FIG. 6. *Dinobothrium plicitum.* Transverse section of proglottis near scolex. Longer diameter, 1.20 mm. For explanation of lettering, see p. 9.

PLATE 3.

FIG. 7. *Dinobothrium planum.*

A. Portion of strobile with ripe proglottides. Breadth, 4 mm. For explanation of lettering see p. 9.

B. Eggs. Diameters, 0.012 to 0.015 mm.

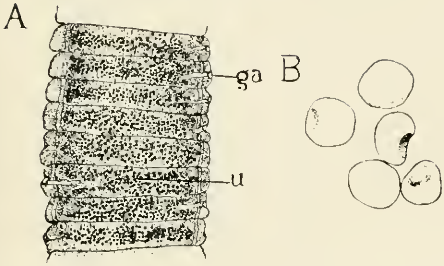
FIG. 8. *Dinobothrium planum.*

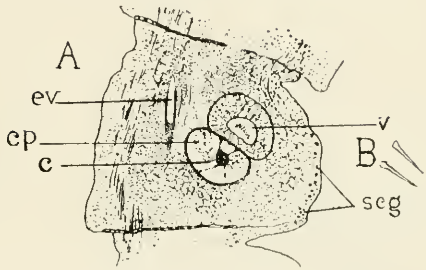
A. Sagittal section near lateral margin of proglottis. Length of proglottis, 0.4 mm. For explanation of lettering see p. 9.

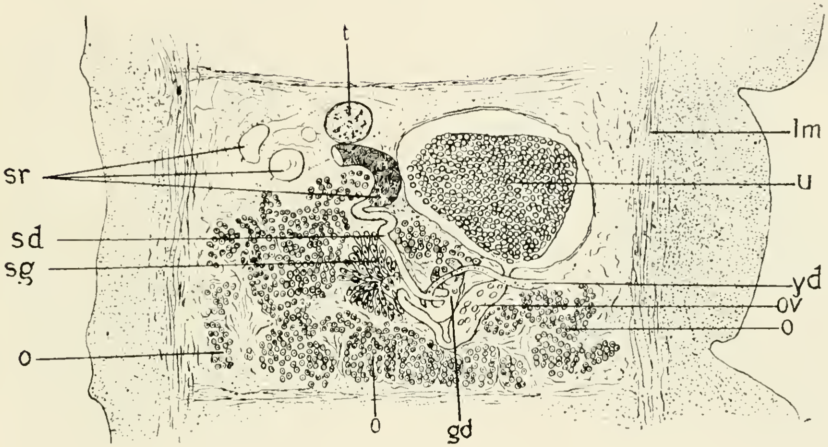
B. Spines from cirrus. Length, 0.015 mm.

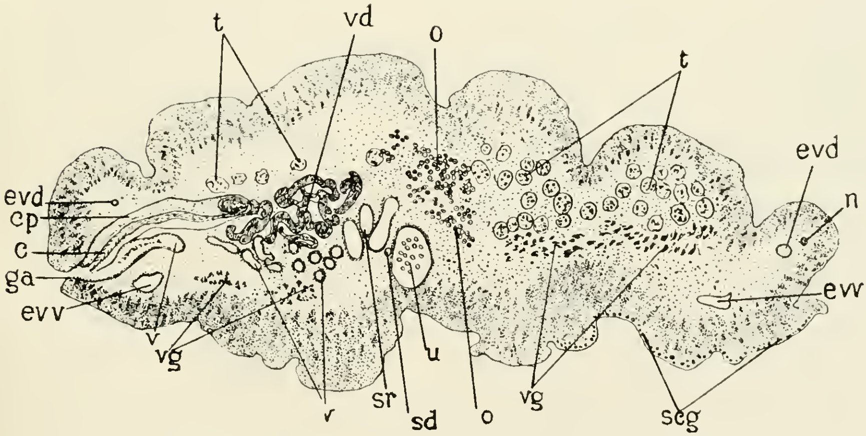
FIG. 9. *Dinobothrium planum.* Median sagittal section of proglottis, partly diagrammatic, more than one section having been used in representing the anatomy in the region of the shell gland. Length of proglottis, 0.4 mm. For explanation of lettering see p. 9.

FIG. 10. *Dinobothrium planum.* Transverse section of mature proglottis, partly diagrammatic, about three sections having been used in representing the vagina and cirrus. Length of longer diameter of section, 3 mm. For explanation of lettering see p. 9.



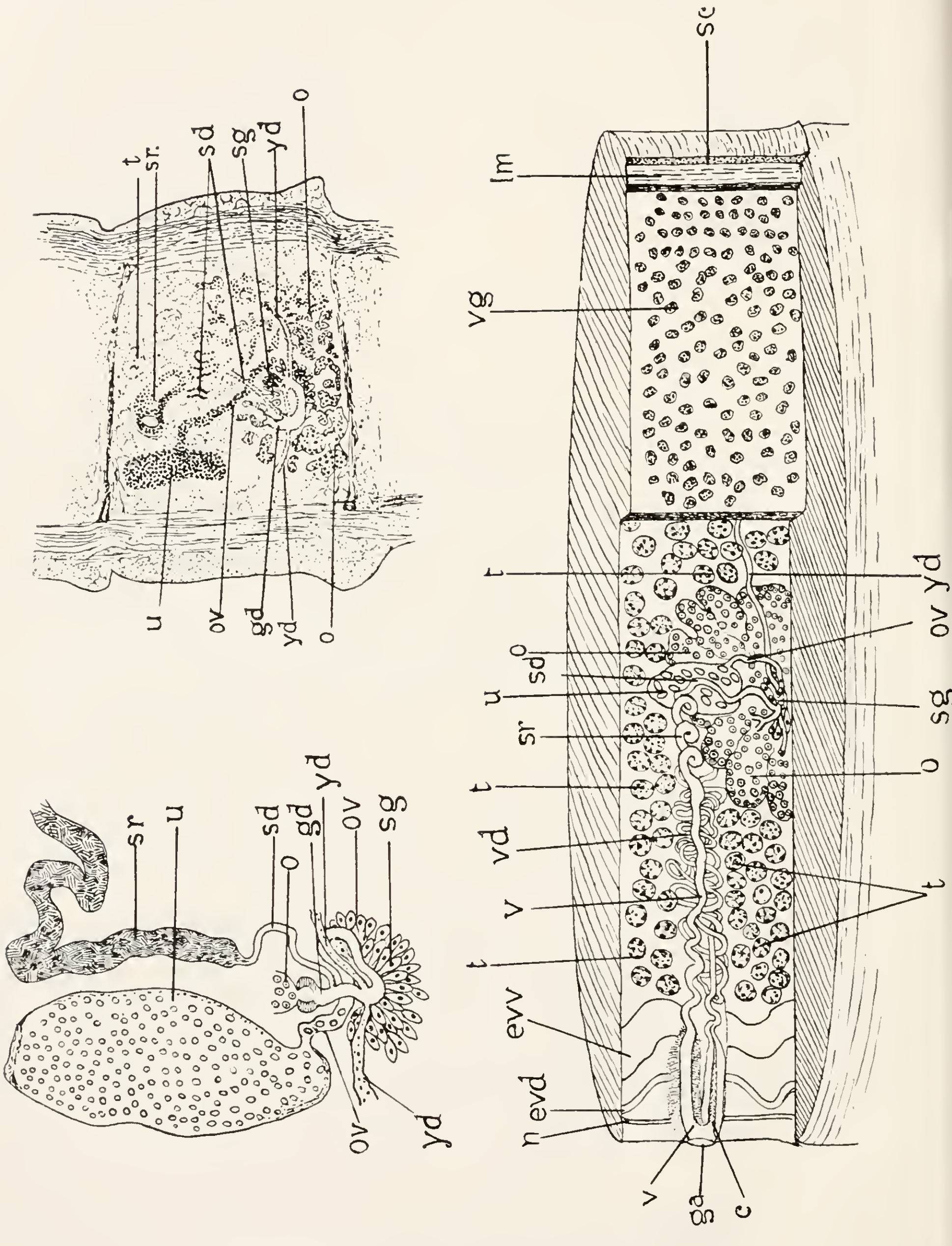






DINOBOTHRIUM PLANUM FROM CETORHINUS MAXIMUS

FOR EXPLANATION OF PLATE SEE PAGE 12.



DINOBOTHRIUM PLANUM FROM CETORHINUS MAXIMUS

FOR EXPLANATION OF PLATE SEE PAGE 13.

Plate 4.

Fig. 11. *Dinobothrium planum.* Median sagittal section of immature proglottis, partly diagrammatic, more than one section having been used in representing the anatomy in the region of the shell gland. Length of proglottis, 0.4 mm. For explanation of lettering see p. 9.

Fig. 12. *Dinobothrium planum.* Diagram of part of female reproductive organs. For explanation of lettering see p. 9.

Fig. 13. *Dinobothrium planum.* Stereogram of mature proglottis, view from ventral side. For explanation of lettering see p. 9.

THE CENTIPEDS OF CENTRAL AMERICA.

By Ralph V. Chamberlin,

Of the Museum of Comparative Zoology, Cambridge, Massachusetts.

This paper is primarily a report upon the centipeds from the Central American region contained in the collections of the United States National Museum. Surprisingly little has been done upon the centiped and milliped fauna of this region; and that our knowledge is still far from complete is amply attested by the percentage of new forms appearing in each additional collection studied, this being especially noticeable in the case of the much more numerous millipeds with their more restricted distributions. The millipeds will be treated in a separate report to follow. The centipeds now known from the several countries of the region under consideration are listed separately below.

PANAMA.

Scolopocryptops miersii Newport.
Rhysida nuda (Newport).
Cupipes ungulatus Meinert.
Scolopendra subspinipes Leach.
Scolopendra morsitans Linnaeus.
Pselliodes nigrovittatus (Meinert).
Orphnaeus brevilabiatus (Newport).

COSTA RICA.

Cryptops bivittatus Pocock.
Otocryptops melanostomus (Newport).
Newportia longitarsis (Newport).
Newportia rogersi Pocock.
Otostigmus denticulatus (Pocock).
Otostigmus scabricaudus (Humbert and Saussure).
Rhysida nuda (Newport).
Rysida longipes (Newport).
Scolopendra viridis Say.
Scutigera linceci Wood.
Scutigera nubila, new species.
Labrobius costaricensis (Brölemann).
Notiphilides maximiliani (Humbert and Saussure).

NICARAGUA.

Otocryptops melanostomus (Newport).
Rhysida nuda (Newport).
Rhysida celeris (Humbert and Saussure).
Scolopendra viridis Say.
Scutigera linceci Wood.
Orphnaeus brevilabiatus (Newport).

SAN SALVADOR.

No centipeds recorded.

HONDURAS.

Cryptops pugnans, new species.
Otocryptops ferrugineus (Linnaeus).
Otocryptops melanostomus (Newport).
Newportia stolli (Pocock).
Newportia mimetica, new species.
Newportia sulana, new species.
Scolopendra viridis Say.
Scolopendra gigantea Linnaeus.
Scolopendra polymorpha gaumeri Pocock.
Ityphilus ceibanus, new species.
Tanophilus hondurasanus, new species.
Orphnaeus brevilabiatus (Newport).
Suturodes tardus, new species.

BRITISH HONDURAS.

Rhysida nuda (Newport).
Scolopendra sumichrasti Saussure.
Scolopendra polymorpha gaumeri Pocock.
Scolopendra morsitans Linnaeus.

GUATEMALA.

Cryptops micrus, new species.
Otocryptops ferrugineus (Linnaeus).
Otocryptops melanostomus (Newport).
Newportia stolli Pocock.
Newportia divergens, new species.
Otostigmus denticulatus (Pocock).
Rhysida nuda (Newport).
Cormocephalus aurantiipes (Newport).
Scolopendra sumichrasti Saussure.
Scolopendra viridis Say.
Scutigera linceci Wood.
Labrobius vulcani (Pocock).
Labrobius cobulcanus, new species.
Sowubius stolli (Pocock).
Sotimpius decodontus (Pocock).
Sogolabis scapheus Chamberlin.
Schendylellus hodites Chamberlin.
Sogodes difficilis, new species.
Orphnaeus brevilabiatus (Newport).
Notiphilides maximiliani (Humbert and Saussure)
Suturodes guatemalae, new species.
Suturodes stolli (Pocock).

The United States National Museum material studied is chiefly from Honduras, collected by Dr. W. M. Mann, and from Guatemala, collected by Dr. O. F. Cook and G. P. Goll. Eleven of the 12 new forms described are from these two countries. The total number of species listed is 43.

Order SCOLOPENDROMORPHA.

Family CRYPTOPIDAE.

Genus CRYPTOPS Leach.

1. CRYPTOPS BIVITATTUS Pocock.

Cryptops bivitattus POCOCK, Journ. Linn. Soc. London, 1894, vol. 24, p. 462.—KRAEPELIN, Revision der Scolopend., 1903, p. 50.

Locality.—Costa Rica.

2. CRYPTOPS MICRUS, new species.

Plate 1, fig. 2.

In the type of this species the basal plate overlaps the cephalic. Cephalic plate with paired longitudinal sulci. Basal plate with semicircular cervical groove and paired longitudinal sulci. Anterior margin of prosternum gently doubly bowed. Sulci of anterior plates complete. Last ventral plate with sides straight and converging caudad. Coxopleurae not produced caudad; pores few, only about four on each side in the type.

Characterized particularly by features of the anal legs. In these the femur wholly lacks teeth and true spines and the tibia has only a single tooth at distal end beneath. Both femur and tibia bear ventrally numerous stout setae, with sparse fine hairs above. Metatarsus with four teeth below and the first tarsal joint with two. Tibia and first tarsal joint furrowed and notched at distal end above.

Length, about 10 mm.

Locality.—Guatemala: Trece Aguas, one specimen, June, 1907 (O. F. Cook).

Type.—Cat. No. 24118, U.S.N.M.

3. CRYPTOPS PUGNANS, new species.

Among American forms similar to the Cuban *C. cornifer* Chamberlin and the Argentinian *C. galatheae* Meinert in having paired sulci extending over the full length of the cephalic plate. It agrees with *C. cornifer* in having the first dorsal plate with a transverse sulcus that is evenly curved, not at all angled at the middle, which the paired and parallel longitudinal sulci attain but do not cross. Prosternal margin doubly convex; bristles 7+7. Tarsi distinctly biarticulate, excepting a few of the most anterior. Last ventral

plate with sides converging, its caudal margin widely incurved. Coxopleurae not produced caudally; pores moderate in number. Femur of anal legs armed below and laterally with numerous spines excepting a median longitudinal naked area below, as in *C. cornifer;* sulcate above, at distal end, with a stout curved spine on mesal side. Tibia also with slender spines beneath; at distal end above with two stout spines. Metatarsus similarly with two stout spines at distal end above and with seven teeth beneath. First tarsal joint with three teeth beneath. Proximal joints of penult and preceding legs also with numerous spines beneath. Tibiae and metatarsi of penult legs subdensely setose beneath, the former also with some spines.

Length, 15.5 mm.

Locality.—Honduras: Progreso, one specimen (W. M. Mann).

Type.—Cat. No. 24119, U.S.N.M.

A smaller form than the Cuban *C. cornifer* Chamberlin, to which it seems most closely related. It differs in its biarticulate tarsi, the presence of two stout spines at distal end of tibia of anal legs instead of one, of seven teeth below on metatarsus instead of ten, etc.

Genus OTOCRYPTOPS Haase.

4. OTOCRYPTOPS FERRUGINEUS (Linnaeus).

Scolopendra ferruginea Linnaeus, Syst. Nat., ed. 12, 1766, p. 1063.

Otocryptops ferrugineus Kraepelin, Revision der. Scolopend., 1903, p. 72.

Localities.—Honduras: Choloma, one specimen (W. M. Mann); Guatemala.

5. OTOCRYPTOPS MELANOSTOMUS (Newport).

Scolopocryptops melanostomus Newport, Trans. Linn. Soc. London, 1844, vol. 19, p. 406.

Otocryptops melanostoma Pocock, Journ. Linn. Soc. London, 1894, vol. 24, p. 464.

Localities.—Costa Rica: Rio Reventazon (P. P. Calvert), La Palma, and Surubres; Nicaragua; Honduras: San Juan Pueblo, three specimens (W. M. Mann); Guatemala: near Guatemala city.

Genus SCOLOPOCRYPTOPS Newport.

6. SCOLOPOCRYPTOPS MIERSII Newport.

Scolopocryptops miersii Newport, Trans. Linn. Soc. London, 1845, vol. 19, p. 405.

Locality.—Panama.

Genus NEWPORTIA Gervais.

7. NEWPORTIA STOLLI (Pocock).

Scolopendrides stolli Pocock, Biol. centr. Amer., 1896, p. 31, pl. 3, fig. 4.

Newportia stolli Kraepelin, Revis. der Scolopend., 1903, p. 85.

Localities.—Honduras: Progreso, one specimen (W. M. Mann); Guatemala: Quetzaltenango.

The specimen from Honduras is referred with some doubt to this species, as the anal legs are missing. It may possibly, instead, represent the form *N. sulana*, new species, described below.

8. NEWPORTIA LONGITARSIS (Newport).

Scolopocryptops longitarsis NEWPORT, Trans. Linn. Soc. London, 1845, vol. 19, p. 407, pl. 40, fig. 10.

Newportia longitarsis GERVAIS, in Ins. Apt., 1847, vol. 4, p. 298.

Locality.—Costa Rica: Reventazon Valley, Juan Viñas (P. P. Calvert).

9. NEWPORTIA ROGERSI Pocock.

Newportia rogersi POCOCK, Biol. Centr. Amer., Chilopoda, 1896, p. 33, pl. 3, figs. 6–6*d*.

Localities.—Costa Rica: Volcan de Irazu, Cocos, San José.

10. NEWPORTIA MIMETICA, new species.

This species is close to the Guatemalan *N. stolli* (Pocock). As in that species, the head has paired longitudinal sulci extending from the caudal margin forward to or a little beyond the middle; these sulci not connected posteriorly by any transverse line. Cervical sulcus evenly curved, in the types covered by the cephalic plate or free only at the middle. Paired sulci of first plate parallel and unbranched, extending forward in front of transverse sulcus. Paired sulci extending across anterior third of second tergite, but complete on the others to the twenty-second, inclusive. Last tergite without a median sulcus. Prosternum with dental plates short and broad, convex. Last tergite without a median sulcus. Tarsi undivided excepting in last two pairs of legs. Tibiae of anterior legs armed beneath at distal end but not laterally. Last ventral plate with sides converging caudad, caudal margin mesally incurved, corners rounded. Coxopleural processes nearly glabrous, lacking the pilosity on external side present in *N. stolli* and *N. sulana*. Anal and penult legs also with but very few hairs on mesal surface in contrast with the condition in *N. stolli*.

The general form of the anal legs as in *N. stolli*, the tarsal division similarly proportioned and without claw. Femur of anal legs flattened within; lower edge typically with five distally curved teeth, of which the two anterior ones are smaller; upper edge with a number of points or spinules, and below them, on mesal surface, some still more minute points or prickles. Differing from *N. stolli* in having the two ventral teeth of the tibia situated one well behind the middle and one in front of it instead of both being in front of it.

Length, 15–19 mm.

Locality.—Honduras: Lombardia, three specimens (W. M. Mann).

Type.—Cat. No. 24120, U.S.N.M.

In one of the paratypes the head plate is abnormally widely overlapped by the first tergite.

11. NEWPORTIA DIVERGENS, new species.

Plate 1, fig. 1.

Head with paired sulci extending forward to middle, these not connected across base. The first dorsal plate differs from that of the related *N. stolli* and *N. sulana* and *N. mimetica*, as well as the less closely related forms, in not having the cervical or transverse sulcus cross the middle; that is, the segment of the sulcus between the paired sulci is missing, the paired sulci being thus, in effect, bifurcate, the main branch continuing forward and the other curving ectocephalad.

The characters of the posterior legs essentially as in *N. stolli*, the spining and hair being the same, or nearly so, though the minute spinules on the mesal face of the femur appear to be more numerous and more evenly distributed. The spinules or teeth on the tibia vary considerably. While typically two in number on the proximal half, a third may be present on the distal half and the spinules larger in size, and, on the other hand, in one specimen there is but a single spine on one of the legs.

Length, about 27 mm.

Locality.—Guatemala: Joyabaj, San Rafael, nine specimens (O. F. Cook, 1906 and 1914).

Type.—Cat. No. 24121, U.S.N.M.

12. NEWPORTIA SULANA, new species.

Plate 1, fig. 3.

Agreeing in general with *N. stolli*, thus far with certainty known from only a single specimen taken at Quetzaltenango, Guatemala, excepting that the tarsus of the anal legs ends in a distinct, though straight, claw, as in *N. amazonica* Brölemann. The posterior pairs of legs are densely pilose over the mesal (caudal) surface and the coxo-pleural processes are also pilose ectally and above.

Length, 21.5 mm.

Locality.—Honduras: San Pedro, Sula, one complete specimen and two specimens lacking anal legs (W. M. Mann).

Type.—No. 24122, U.S.N.M.

Analogy with *N. amazonica* Brölemann and *N. unguifer* Chamberlin, both known from numerous specimens, indicates that the claw in the present form is likewise a constant character.

Family OTOSTIGMIDAE.

Genus OTOSTIGMUS Porat.

13. OTOSTIGMUS DENTICULATUS (Pocock).

Parotostigmus denticulatus POCOCK, Biol. Centr. Amer., Chilopoda, 1896, p. 25.

Otostigmus denticulatus KRAEPELIN, Revis. der Scolopend., 1903, p. 124.

Localities.—Costa Rica: San José; Guatemala.

14. OTOSTIGMUS SCABRICAUDUS (Humbert and Saussure).

Branchiostoma scabricauda HUMBERT and SAUSSURE, Rev. et Mag. Zool., 1870, vol. 22, p. 203.

Otostigmus scabricaudus KRAEPELIN, Revis. der Scolopend., 1903, p. 123, fig. 61.

Localities.—Costa Rica: San Mateo, Cocos.

Genus RHYSIDA Wood.

15. RHYSIDA NUDA (Newport).

Branchiostoma nudum NEWPORT, Trans. Linn. Soc. London, 1845, vol. 19, p. 412.

Rhysida nuda KRAEPELIN, Revis. der Scolopend., 1903, p. 144.

Localities.—Panama: Volcan de Chiriqui, Oriental region; Nicaragua: Greytown; Costa Rica: San José; British Honduras: Stann Creek, Belize (Robertson).

16. RHYSIDA LONGIPES (Newport).

Branchiostoma longipes NEWPORT, Trans. Linn. Soc. London, 1845, vol. 19, p. 411.

Rhysida longipes POCOCK, Biol. Centr. Amer., Chilopoda, 1896, p. 27.

Locality.—"Central America."

17. RHYSIDA CELERIS (Humbert and Saussure).

Branchiostoma celer HUMBERT and SAUSSURE, Rev. et Mag. Zool., ser. 2, vol. 22, p. 202.

Rhysida celeris KRAEPELIN, Revis. der Scolopend., 1903, p. 149.

Locality.—Nicaragua (McNeil coll.).

Family SCOLOPENDRIDAE.

Genus CUPIPES Kohlrausch.

18. CUPIPES UNGULATUS Meinert.

Cupipes ungulatus Proc. Amer. Philos. Soc., 1886, vol. 23, p. 187.

Locality.—Panama.

Genus CORMOCEPHALUS Newport.

19. CORMOCEPHALUS AURANTIIPES (Newport).

Scolopendra aurantiipes NEWPORT, Ann. and Mag. Nat. Hist., 1844, vol. 13, p. 99.

Cormocephalus aurantiipes NEWPORT, Trans. Linn. Soc. London, 1845, vol. 19, p. 420.

Locality.—Guatemala (F. M. Müller).

A single specimen in the collection of the Museum of Comparative Zoology labeled as coming from Guatemala is this form. It had probably escaped from some ship, as the species is characteristically Australian.

Genus SCOLOPENDRA Linnaeus.

20. SCOLOPENDRA GIGANTEA Linnaeus.

Scolopendra gigantea LINNAEUS, Syst. Nat., ed. 10, 1758, p. 638.

Locality.—Honduras.

21. SCOLOPENDRA SUMICHRASTI Saussure.

Scolopendra sumichrasti SAUSSURE, Mém. Soc. Phys. Genève, 1860, vol. 15, p. 385, pl. 7, fig. 46.

Localities.—British Honduras: Belize; Guatemala: Tucuru, in Vera Paz, Livingston.

22. SCOLOPENDRA POLYMORPHA GAUMERI Pocock.

Scolopendra polymorpha gaumeri POCOCK, Biol. Centr. Amer., Chilopoda, 1895, p. 20.

Localities.—Honduras: Bonaca Island, in Bay of Honduras; British Honduras.

23. SCOLOPENDRA VIRIDIS Say.

Scolopendra viridis SAY, Proc. Acad. Nat. Sci. Philadelphia, 1821, p. 110.
Scolopendra nicaraguensis BOLLMAN, Bull. U. S. Nat. Mus., 1893, No. 46, p. 198.

Localities.—Costa Rica: Juan Viñas (P. P. Calvert), Caché; Nicaragua: Ocotal (W. B. Richardson, Dr. Bransford); Honduras (C. H. Townsend); Guatemala: Quetzaltenango, Volcan de Pacaya, Guatemala city, Antigua, San Miguel Upsantan.

24. SCOLOPENDRA MORSITANS Linnaeus.

Scolopendra morsitans LINNAEUS, Syst. Nat., ed. 10, 1758, p. 638.

Localities.—Panama; British Honduras: Belize (W. A. Stanton), St. Johns College (Wm. Bennett).

25. SCOLOPENDRA SUBSPINIPES Leach.

Scolopendra subspinipes LEACH, Trans. Linn. Soc., 1814–15, vol. 11, p. 383.

Locality.—Panama: Canal Zone, Tabernilla.

Order SCUTIGEROMORPHA.

Family SCUTIGERIDAE.

Genus PSELLIODES Chamberlin.

26. PSELLIODES NIGROVITTATA (Meinert).

Scutigera nigrovittata MEINERT, Proc. Amer. Philos. Soc., 1886, vol. 23, p. 173.

Locality.—Panama. This is the type locality for the species.

Genus SCUTIGERA Lamarck.

27. SCUTIGERA LINCECI Wood.

Scutigera linceci Wood, Proc. Acad. Sci. Philadelphia, 1867, p. 42.

28. SCUTIGERA NUBILA, new species.

Plate 1, figs. 4 and 5.

The dorsum is fuscous throughout, without any distinct median paler stripe, though the tergites appear a little darker on the sides than along the middle. The legs are blackish with an indistinct and incomplete paler annulus over middle of femur and tibia and with a vaguer annulus at base of latter on some legs. Articles of antennae very short, much broader than long, first division of flagellum consisting of 79 articles. Head deeply depressed over posterior median region, the depression somewhat furcate between eyes. A shallower median longitudinal furrow on anterior part of head. The stoma-bearing tergites notched or incurved at middle behind, the stoma slightly projecting caudad. Stoma saddles moderately elevated, the stomata of moderate length, on caudal slope of saddles. Last tergite with caudal margin flattened at middle, but not at all excised. Dorsal surface bearing numerous short, slender spines or spiniform setae, all unaccompanied by finer hairs. The slender spines numerous on margins, more sparse over the general surface.

The body of the type is injured at the caudal end, so that the genital forceps cannot be described.

First division of tarsus I composed of 14 articles, the second of 32. First tarsus of seventh legs with 10 articles, the second with 30. First tarsus unspined distally. Second tarsus of anterior legs with pegs beneath in typical manner. Spines present at distal end of tarsus I in median and posterior legs.

Length, 17.5 mm.

Locality.—Costa Rica: Turrialba, one specimen (C. Lankester).

Type.—Cat. No. 24123, U.S.N.M.

Order LITHOBIOMORPHA.

Family GOSIBIIDAE.

Genus LABROBIUS Chamberlin.

29. LABROBIUS VULCANI (Pocock).

Lithobius vulcani Pocock, Biol. Centr. Amer., Chilopoda, 1895, p. 8, pl. 1, figs. 8–8*b*.

Labrobius vulcani Chamberlin, Bull. Mus. Comp. Zool., 1915, vol. 59, p. 536.

Locality.—Guatemala: Volcan de Agua.

30. LABROBIUS COSTARICENSIS (Brölemann).

Lithobius vulcani costaricensis Brölemann, Ann. Soc. Ent. France, 1905, p. 339.

Locality.—Costa Rica: El Reventado.

31. LABROBIUS COBULCANUS, new species.

Plate 1, figs. 6 and 7.

This form is separated chiefly on the characters of the prosternum. This differs from *L. vulcani* (Pocock) in lacking the stout outer third tooth on each side of the prosternum. The prosternal margin extends out horizontally considerably beyond the ectal tooth, much as in *L. minor* Chamberlin; the edge a little ectad of the outer tooth is produced cephalad, the special ectal seta being borne upon the prominence, as shown in figure 6. Articles of antennae, 33 to 39. Ventral spines of penult legs, 0, 1, 3, 3, 1–0, 1, 3, 3, 2, with three claws. Claw of female genital forceps entire; basal spines 2+2, rather stout (fig. 7). Color, chestnut.

Length, 16 mm.

Locality.—Guatemala: Joyabaj, lower slope of Cobulco Mountain, two females, both of which have lost their anal legs (O. F. Cook).

Type.—Cat. No. 24124, U.S.N.M.

Genus SOWUBIUS Chamberlin.

32. SOWUBIUS STOLLI (Pocock).

Lithobius stolli Pocock, Biol. Centr. Amer., Chilopoda, 1895, p. 9, pl. 1, figs. 10–10*c*.

Sowubius stolli Chamberlin, Canad. Ent., 1912, p. 178.

Locality.—Guatemala: Volcan de Agua.

Genus SOTIMPIUS Chamberlin.

33. SOTIMPIUS DECODONTUS (Pocock).

Lithobius decodontus Pocock, Biol. Centr. Amer., Chilopoda, 1895, p. 9, pl. 1, figs. 9–9*b*.

Sotimpius decodontus Chamberlin, Canad. Ent., 1912, p. 177.

Locality.—Guatemala: Volcan de Acatenango.

Order GEOPHILOMORPHA.

Family SCHENDYLIDAE.

Genus SOGOLABIS Chamberlin.

34. SOGOLABIS SCAPHEUS Chamberlin.

Sogolabis scapheus Chamberlin, Psyche, 1920, vol. 27, p. 64.

Locality.—Guatemala: Coban.

The type of this species was taken actually at Washington, District of Columbia, but from soil about roots of the pacaya or salad palm (*Chamaedorea*) at quarantine, imported from Coban.

Genus SCHENDYLELLUS Chamberlin.

35. SCHENDYLELLUS HODITES Chamberlin.

Schendylellus hodites Chamberlin, Psyche, 1920, vol. 27, p. 65.

Locality.—Guatemala: Coban.

The type was also taken at quarantine in Washington, District of of Columbia, from about roots of the Chamaedorea imported from Coban.

SOGODES, new genus.

Labrum having the wide median arc armed with chitinous teeth. Claw of palpus of second maxillæ smooth. No ventral pores. Coxal glands of last pediferous segment two on each side, these simple or homogeneous. Last ventral plate wide. Anal leg composed of a total of seven articles, the last ending in a well-developed claw.

Genotype.—*Sogodes difficilis*, new species.

In the presence of a claw on the anal legs resmbling *Nyctunguis*, the species of which occur along the Californian coast, but differing in lacking ventral pores and in having the claw of the second maxillæ smooth.

36. SOGODES DIFFICILIS, new species.

Plate 2, figs. 1 and 2.

Color, pale fulvous. Head slightly wider than long; widest behind middle, from where narrowed to caudal end and also forward; anterior margin weakly angular; caudal margin wide, slightly incurved (fig. 1). Antennae short, filiform; joints mostly short, especially the more distal ones, excepting the ultimate, which equals the three preceding ones in length. Prebasal plate exposed at middle. Basal plate four times as wide as long. Claws of prehensors, when closed, much short of attaining anterior margin of head; the prehensors being very short, the mesal margin of femuroid extending but little beyond margin of prosternum; all joints unarmed. Prosternum unarmed; chitinous lines present, fine. First legs much shorter than the second, the second but little shorter than the third. Dorsum bisulcate. Coxopleurae of last legs with two simple glands on each side, the anterior pore smaller than the posterior (fig. 2). Last ventral plate broad, narrowed caudad. Pairs of legs, 63.

Length, 13 mm.

Locality.—Guatemala: San Rafael, one specimen, June 4, 1914 (O. F. Cook).

Type.—Cat. No. 24125, U.S.N.M.

Family BALLOPHILIDAE.

Genus ITYPHILUS Cook.

37. ITYPHILUS CEIBANUS, new species.

Plate 3, fig. 1.

Distinguishable from *I. guianensis* Chamberlin, of British Guiana, in the much larger number of pairs of legs, though the total number of pairs of legs is not ascertainable because the caudal end of the type is missing. Sixty-nine pairs are now present in the incomplete specimen, as against a total of from 49 to 55 in *guianensis*. From *I. lilacinus* Cook, of the Florida keys, the only other known species, it differs in the form of the cephalic plate, this being longer than wide instead of wider than long. The second tergite is broader and rather shorter as compared with the first, these two being slightly wider than the cephalic plate and obviously wider than the immediately following tergites. The antennae more strongly clavate and flattened than in *lilacinus*, with the ultimate article less acuminate; strongly geniculate. Prosternum essentially as in *lilacinus*.

Length of incomplete type (head+69 segments), 20 mm.

Locality.—Honduras: La Ceiba (W. M. Mann).

Type.—No. 24126, U.S.N.M.

TANOPHILUS, new genus.

Agrees with *Ballophilus* and differs from *Ityphilus* in having the ventral pores in a definite, transversely elliptical area which is more strongly chitinized and elevated above the general surface of the sternite. May be distinguished from *Ballophilus* and *Prionothalthybius* in having only a single large pit on each coxopleura of last pediferous segment, several smaller pores opening into each pit.

Genotype.—Tanophilus hondurasanus, new species.

38. TANOPHILUS HONDURASANUS, new species.

Plate 2, figs. 3 and 4.

The general color in alcohol is ferruginous, but in life may have had the dark-violet pigmentation typical for *Ballophilus*. Head with no frontal suture, longer than wide, widest near middle, the sides and anterior margin convex, the caudal margin truncate. Antennae strongly clavate, distally flattened, conspicuously geniculate (fig. 3). Basal plate narrowed caudad, two and a half times wider than long. Prosternum with chitinous lines distinct and complete; anterior margin angularly excised. Prehensors small, not attaining the front margin of the head. Dorsal plates strongly bisulcate, laterally somewhat roughened. Ventral pores beginning on first sternite. Last ventral plate strongly narrowed caudad. the sides

straight or nearly so, partly overlapping the large coxal pit on each side. Anal legs strongly thickened proximally and conically narrowing distad, the last joint pointed and clawless (fig. 4). Pairs of legs, 79.

Length, 31 mm.

Locality.—Honduras: Cecilia, one specimen (W. M. Mann).

Type.—Cat. No. 24127, U.S.N.M.

Family ORYIDAE.

Genus ORPHNAEUS Meinert.

39. ORPHNAEUS BREVILABIATUS (Newport).

Geophilus brevilabiatus NEWPORT, Trans. Linn. Soc. London, 1845, vol. 19, p. 436.

Orphnaeus brasiliensis MEINERT, Naturh Tidsskr., 1870–71, ser. 3, vol. 7, p. 20.

Orphnaeus lividus MEINERT, Naturh. Tidsskr., 1870–71, ser. 3, vol. 7, p. 19.

Orphaneus brevilabiatus POCOCK, Biol. Centr. Amer., Chilopoda, 1896, p. 40.

Localities.—Panama; Nicaragua: Polvon, Occidental Department (McNeil); Honduras: La Ceiba, one specimen; Choloma, two specimens; San Pedro, Sula, one specimen (W. M. Mann); Guatemala: Cacao, Trece Aguas (G. P. Goll), Patulul (W. M. Wheeler).

Genus NOTIPHILIDES Latzel.

40. NOTIPHILIDES MAXIMILIANI (Humbert and Saussure).

Notiphilus maximiliani HUMBERT and SAUSSURE, Rev. et Mag. Zool., 1870, ser. 2, vol. 22, p. 205.

Notiphilides maximiliani LATZEL, Die Myriop. Osterr.—Ungar. Monarch., 1880, vol. 1, p. 20.

Localities.—Costa Rica: San Mateo; Guatemala.

Family CHILENOPHILIDAE.

This group is used to include all genera formerly embraced in the Geophilidae which have a coxopleural suture present and conspicuously chitinized in the second maxillae. While in some genera of the group the coxae of the second maxillae are but weakly united with each other, this character shows considerable variation and does not hold for most of the West Indian and Central American forms placed here by the author. Because of indications of transition the group may ultimately prove untenable; but pending further extension of our knowledge it is retained for its obvious convenience.

SUTURODES, new genus.

Head without frontal suture or this but vaguely indicated. Antennae short, filiform. Basal plate wide, trapeziform, overlapped by

the cephalic plate. Labrum free, tripartite. Median piece large, protruding caudad, and armed with a series of long teeth. Lateral pieces fringed with pale spinescent processes. First maxillae with inner and outer branches distinctly set off from coxal plate. Outer branch biarticulate, with two long membranous lappets. Second maxillae with coxae completely and broadly united at middle, as in *Nesidiphilus*, though the median part is commonly more membranous. Coxopleural suture strongly chitinized, anteriorly curving about ectal edge of pore, where it may be only weakly indicated. Ventral sclerites strongly developed, extending far forward and united at anterior end by a small median piece. Palpus triarticulate, terminating in a simple smooth claw; none of joints with a process. Prehensors large, exposed from above and extending beyond front margin of head. Claw and femuroid armed within and prosternum armed anteriorly. Prosternum without chitinous lines. Ventral pores normally in four areas, one on each quarter of plate, as in *Nesidiphilus*, etc. Last ventral plate narrow. Coxopleurae of last legs elongate, usually considerably exposed from above, and bearing very numerous small pores. Anal legs with six joints beyond coxae, clawless.

Genotype.—Suturodes tardus, new species.

This genus differs from the West Indian genus *Nesidiphilus* in the position of the coxopleural suture, this in the latter genus always ending at the margin mesad of or caudomesad of the pore, as also it does in the closely related *Telocricus* (pl. 4, fig. 5), whereas in the present group this suture curves about the ectal edge of the pore in the more usual manner (pl. 3, fig. 4).

41. SUTURODES TARDUS, new species.

Plate 2, fig. 5; plate 3, figs. 2, 3, and 4; plate 4, figs. 3 and 4.

Flavous, the head and prehensors and a few anterior tergites typically of a dilute chestnut tinge. Head about 1.68 times longer than wide; widest at caudal end of frontal region, from where the sides are parallel or converge but slightly caudad to the oblique caudal corners and more strongly forward. Anterior margin a little convex at middle. Caudal margin straight (pl. 4, fig. 3). Articles of antennae moderately long, the ultimate clearly shorter than the two preceding taken together. No distinct clypeal areas excepting the small, pale spots from which the principal, more median setae arise. Ectad of each of these setae of the median pair a series of three or four setae and in front of them and between the antennae a second pair. Caudad of the main transverse series of setae a second series of smaller setae, these 3+3 or 3+4. Caudad of this second series two setae on the median line, one behind the other, with sometimes

a much reduced setae each side of the first of these. Median piece of labrum projecting well caudad of the lateral pieces; bearing typically six long teeth (pl. 4, fig. 4). Coxal plate of first maxillae with a pair of long setae at anterior border, and three or four lesser setae. Setae of coxae of second maxillae few, consisting typically of a submarginal series of four on each side and a group of four at middle. For other features see plate 3, figure 4. Exposed part of basal plate about four times as broad as long. (In the holotype the cephalic plate has been shifted abnormally forward.) Claws of prehensors when closed extending beyond distal end of first antennal article, but not attaining the distal end of the second. Tooth at base of claw black, conical, that of the femuroid similar but larger. Teeth of prosternum short, blunt. See further plate 3, figure 2. Dorsal plates distinctly bisulcate, the paired sulci also traversing the basal plate. Anterior ventral plates with a deep, median longitudinal sulcus. First spiracle large, vertically oval, the second of similar shape and but little smaller. The third more abruptly reduced, the succeeding ones soon becoming circular and small. Last dorsal plate narrow and long, its sides nearly parallel (pl. 2, fig. 5). Last ventral plate very narrow, its sides a little converging caudad, toward caudal end rounding in to caudal margin. Coxopleural pores small and very numerous ventrally, laterally, and dorsally (pl. 3, fig. 3). Pairs of legs, 69 to 71.

Length, 42 mm.

Locality.—Honduras: San Juan Pueblo, two specimens (W. M. Mann).

Type.—Cat. No. 24128, U.S.N.M.

42. SUTURODES GUATEMALAE, new species.

Plate 3, fig. 5; plate 4, figs. 1 and 2.

Resembling *S. stolli* (Pocock) in general. Frontal plate not discrete, but vaguely indicated in part only as a pale line. Head widest near level of this line, the sides moderately converging caudad instead of being parallel. The anterior corners are not widely rounded, as represented in the figure of *S. stolli*, but are a little obtusely angular, the anterior margin of the head being in the form of a very obtuse angle. The length of the exposed portion of the basal plate is much less than half its anterior width, being overlapped by head and by first tergite; it bears a single transverse series of setae. It differs from *stolli*, according to notes on the latter given by Attems,[1] in having two small clypeal areas, each bearing a seta instead of a single nonsetigerous area. In front of the two setae of these areas in the present species is a second pair

[1] Schulze, Forschungsr. in West, u. Zentr. Südafrika, vol. 2, Abt. 1, p. 35.

of setae, and caudad and laterad of them are four or five setae on each side in two series, the total number of setae being thus 12 or 13; all are very short (pl. 4, fig. 1). Median piece of labrum large, bearing six teeth. Coxae of second maxillae broadly united, pores opening through mesal edge. The chitinous coxopleural suture is strongly marked in its caudal half, becoming weaker anteriorly where it curves around the ectal side of the pore. The lappets of the first maxillae are long and conspicuous, but that of the second joint is smaller proportionately to that of the first than in *tardus*. Anterior margin of prosternum with two reduced, almost obsolete teeth. Femuroid of prehensors armed within at distal end with a rounded tooth, claw at base with a dark, conical tooth. Other joints unarmed (pl. 4, fig. 2). First spiracle vertically elliptic, much larger than the second. The second and following spiracles circular. Last ventral plate narrow; sides converge caudad, more strongly so toward caudal ends; caudal margin straight. Coxopleural pores numerous, but fewer above than in *tardus*. Last dorsal plate broader than in the latter species (pl. 3, fig. 5). Anal legs in male but little thickened; with numerous very short hairs on ventral surface of proximal joints. Pairs of legs (male), 59.

Length, about 21 mm.

Locality—Guatemala: San Rafael, June 4, 1914. (O. F. Cook).

Type—No. 24129, U.S.N.M.

43. SUTURODES STOLLI (Pocock).

Geophilus stolli Pocock, Biol. Centr. Amer. Chilopoda, 1896, p. 38, pl. 3, figs. 9–9c.

Pachymerium stolli Attems, Schulze Forschungsr. im West. u. Zentr. Südafrika, 1909, vol. 2, Abt. 1, p. 35, fig. 5.

This species is listed under *Suturodes* with but little doubt, although I have not seen specimens of the form. Attems places the species in *Pachymerium*, of the Geophilidae proper; but his figure shows a coxopleural suture as developed posteriorly. This suggests the condition in the preceding species, in which the posterior part of the suture is strongly chitinous and conspicuous, while the anterior part is weaker and quite likely to be overlooked in the unmounted maxillae.

EXPLANATION OF PLATES.

The plates were drawn by the author.

Plate 1.

Newportia divergens.

Fig. 1. Head and first segments, dorsal view × 17.

Cryptops micrus.

2. Last leg, mesal view × 65.

Newportia sulana.

3. Distal end of tarsus of last leg×65.

Scutigera nubila.

4. Caudal portion of fifth tergite×45.
5. Last tergite and caudal border of preceding one, in outline×45.

Labrobius cobulcanus.

6. Anterior portion of prosternum×65.
7. Basal joint and spines of left genital forceps of female, ventral view×65.

PLATE 2.

Sogodes difficilis.

FIG. 1. Head, dorsal view×48.
2. Glands of left coxopleura of anal legs, in outline×220.

Tanophilus hondurasanus.

3. Head and first tergite, dorsay view×54.
4. Caudal end of body, ventral view×56.

Suturodes tardus.

5. Caudal end, dorsal view×33.

PLATE 3.

Ityphilus ceibanus.

FIG. 1. Head and first plate×76.

Suturodes tardus.

2. Prosternum and prehensors×15.
3. Caudal end, ventral view×33.
4. Maxillae, the right palpus of second pair omitted×63.

Suturodes guatemalae.

5. Caudal end, dorsal view.

PLATE 4.

Suturodes guatemalae.

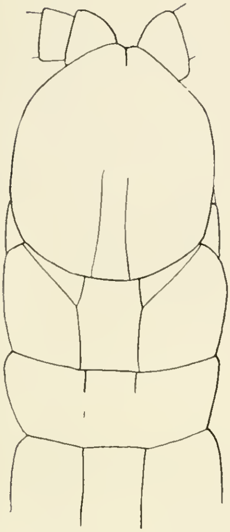
FIG. 1. Anterior portion of head, with maxillae removed, ventral view×49.
2. Prosternum and prehensors×22.

Suturodes tardus.

3. Head and adjacent tergites, dorsal view×15.
4. Labrum×220.

Teloericus marginalis.

5. Coxosternum of second maxillae, showing coxopleural line, etc.×63.



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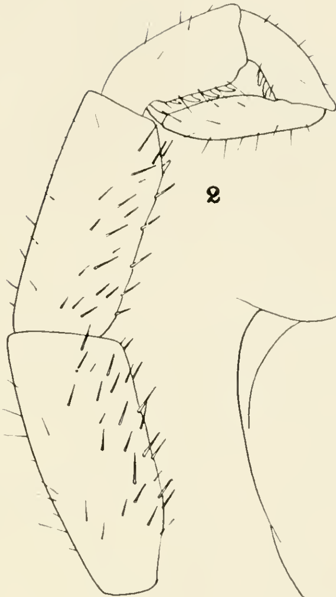

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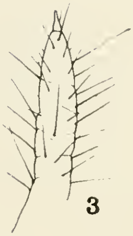

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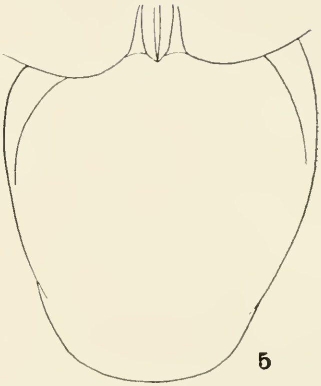

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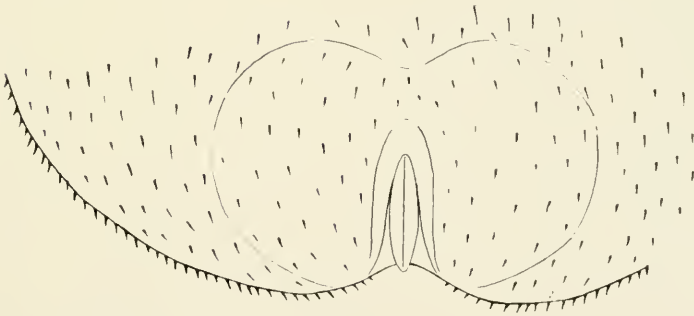

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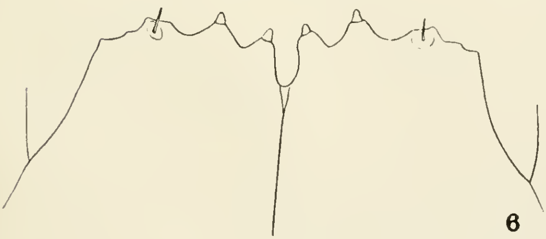

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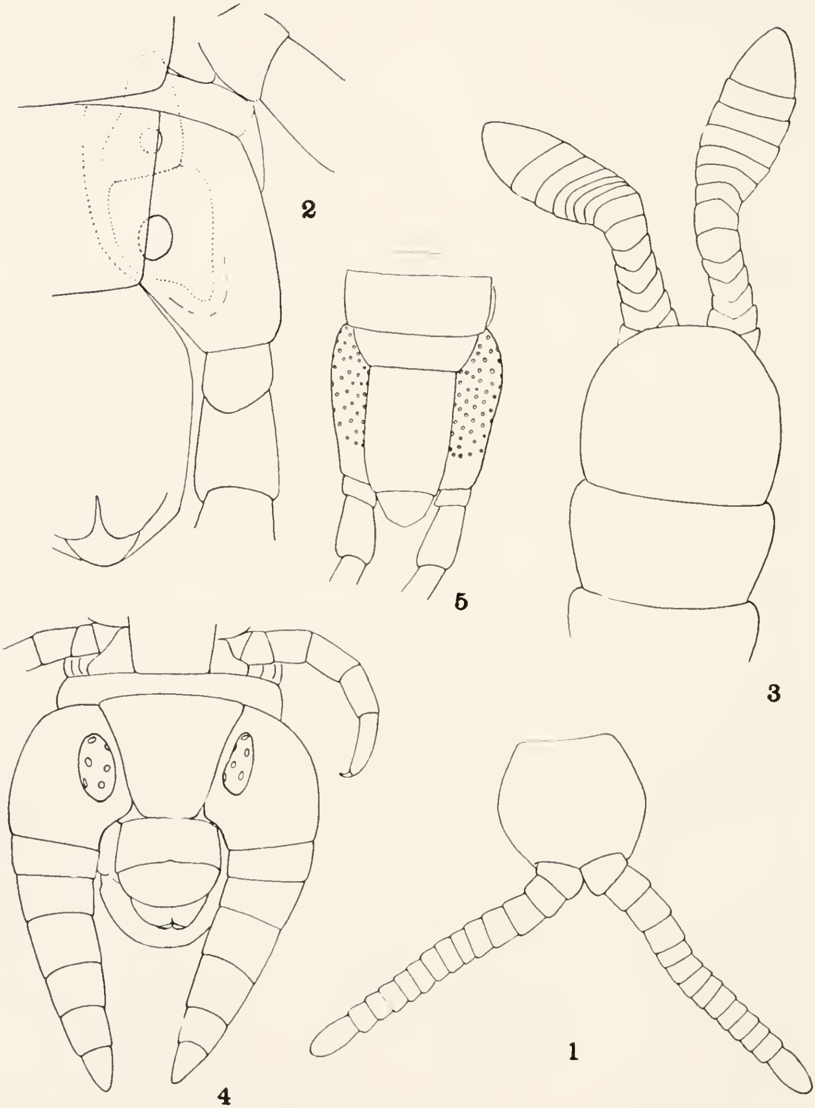
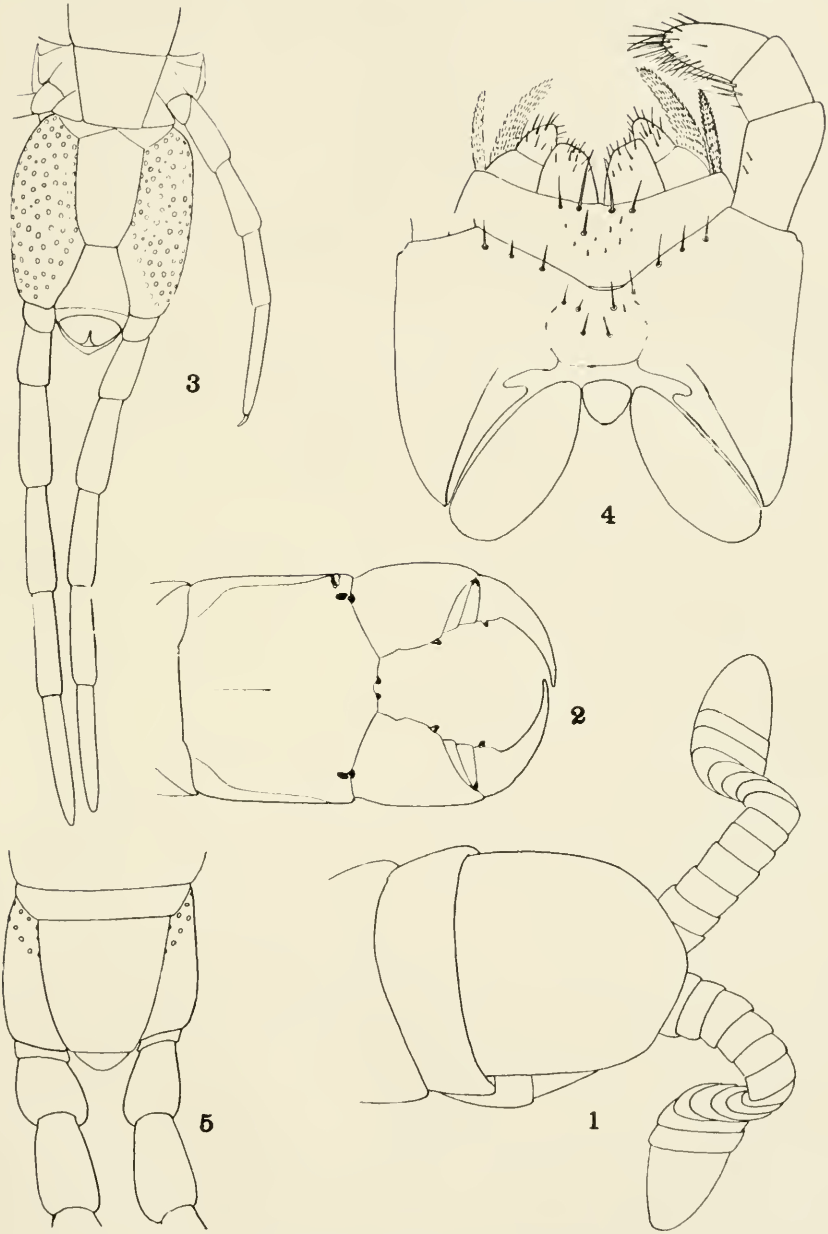
CENTIPEDS OF CENTRAL AMERICA.

FOR EXPLANATION OF PLATE SEE PAGES 16 AND 17.



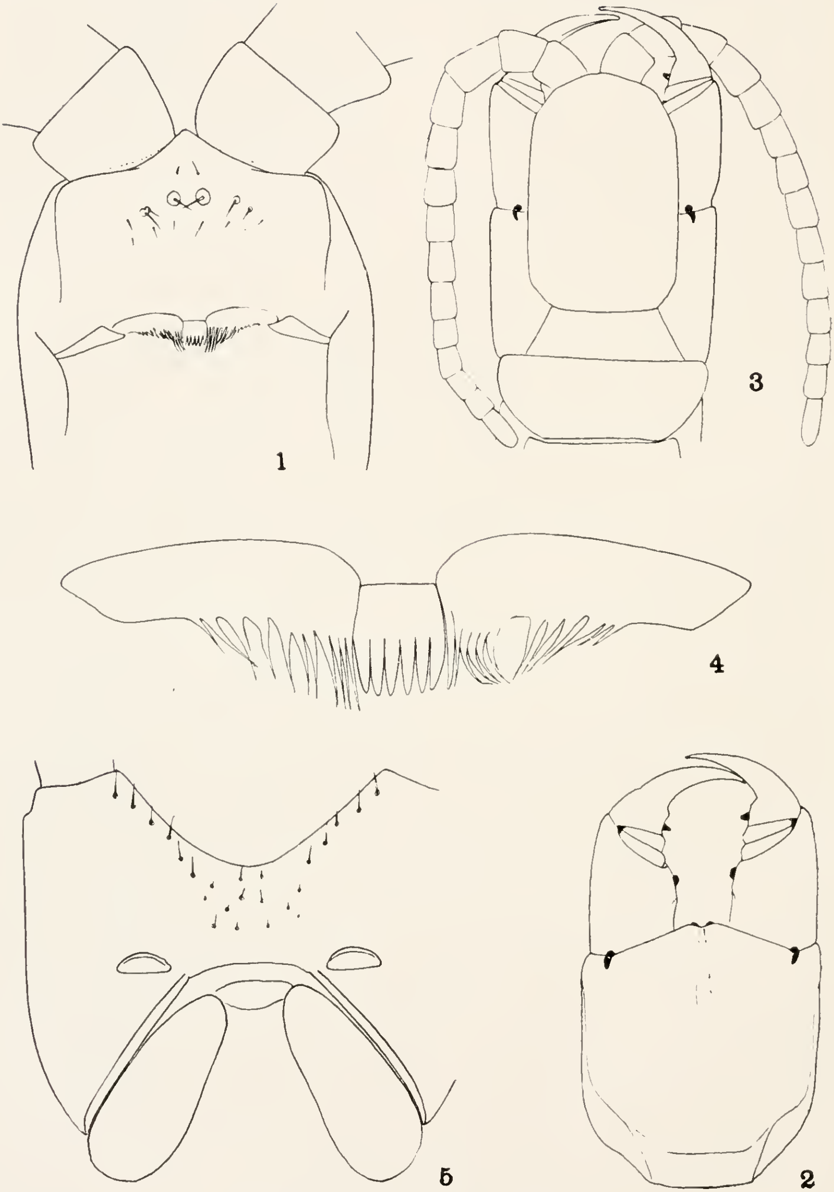
CENTIPEDS OF CENTRAL AMERICA

FOR EXPLANATION OF PLATE SEE PAGE 17.



CENTIPEDS OF CENTRAL AMERICA

FOR EXPLANATION OF PLATE SEE PAGE 17.



CENTIPEDS OF CENTRAL AMERICA

FOR EXPLANATION OF PLATE SEE PAGE 17

THE MILLIPEDS OF CENTRAL AMERICA.

By Ralph V. Chamberlin,

Of the Museum of Comparative Zoology, Cambridge, Massachusetts.

This paper, like its predecessor on the centipeds of the same region, is primarily a report upon the material of the group existing in the collections of the United States National Museum, collections which have been enriched especially by the contributions of Drs. O. F. Cook and W. M. Mann. The collection of the Museum of Comparative Zoology has also been reviewed. In addition to the forms studied in these collections, it has been the intention to include all other species thus far described from Panama, Costa Rica, Nicaragua, Salvador, Honduras, British Honduras, and Guatemala.

The forms now known to occur are listed separately for the several countries below.

PANAMA.

Stemmiulus bioculatus Gervais.
Orthoporus festae (Silvestri).
Diaporus culebrae, new species.
Diaporus chiriquensis (Pocock).
Rhinocricus ferrugineus (Daday).
Rhinocricus hagedussii (Daday).
Rhinocricus ocraceus Brölemann.
Oxypyge varicolor (Silvestri).
Orthomorpha coarctata (Saussure).
Chondrodesmus panamenus, new species.
Alocodesmus dromeus, new species.
Cyrtodesmus granosus (Gervais and Goudot).

COSTA RICA.

Platydesmus lankesteri Brölemann.
Prostemmiulus tristani Silvestri.
Prostemmiulus picadoi Silvestri.
Epinannolene bicornis Brölemann.
Gymnostreptus pacificus, new species.
Orthoporus absconsus, new species.
Orthoporus confragosus (Karsch).
Diaporus palmensis (Brölemann).

Diaporus omalopyge (Brölemann).
Diaporus typotopyge (Brölemann).
Rhinocricus wheeleri, new species.
Rhinocricus centralis, new species.
Rhinocricus simulans, new species.
Rhinocricus rogersi Pocock.
Rhinocricus aposematus Pocock.
Rhinocricus tristani Pocock.
Rhinocricus costaricensis Brölemann.
Rhinocricus nodosicollis Brölemann.
Rhinocricus biolleyi Brölemann.
Rhinocricus plesius Chamberlin.
Rhinocricus mucronatus Brölemann.
Spirostrophus musarum Cook.
Orthomorpha coarctata (Saussure).
Oxidus gracilis (Koch).
Tirodesmus fimbriatus (Peters).
Nyssodesmus nigricaudus, new species.
Nyssodesmus tristani (Pocock).
Nyssodesmus limonensis (Attems).
Nyssodesmus fraternus (Carl).
Nyssodesmus bivirgatus (Carl).
Nyssodesmus riparius (Carl).
Nyssodesmus montivagus (Carl).
Nyssodesmus propinquus (Carl).
Nyssodesmus stenopterus (Brölemann).
Nyssodesmus antius (Chamberlin).
Nyssodesmus pococki (Brölemann).
Amplinus convexus (Carl).
Amplinus niteus, new species.
Aphelidesmus calverti Chamberlin.
Aphelidesmus intermedius Chamberlin.
Aphelidesmus glaphyros (Attems).
Chrondrodesmus singularis, new species.
Chondrodesmus granosus (Carl).
?*Chondrodesmus hoffmanni* (Peters).
Phylactophallus stenomerus Pocock.
Aceratophallus lamellifer Brölemann.
Aceratophallus unicolor Carl.
Aceratophallus dux Chamberlin.
Eusphaeriodesmus stilifer (Pocock).
Colobodesmus biolleyi Brölemann.
Peridontodesmus electus Chamberlin.

NICARAGUA.

Rhinocricus nicaraguanus, new species.
Rhinocricus rixi Pocock.
Rhinocricus marci Pocock.
Tirodesmus fimbriatus (Peters).
Nyssodesmus mimus, new species.
Nyssodesmus nicaraguanus, new species.

SALVADOR.

None recorded.

HONDURAS.

Platydesmus interruptus, new species.
Platydesmus interruptus simplex, new variety.
Siphonophora telana, new species.
Siphonophora progressor, new species.
Prostemmiulus relictus, new species.
Prostemmiulus lombardiae, new species.
Cleidogona ceibana, new species.
Amplinus manni, new species.
Amplinus orphnius, new species.
Chondrodesmus tuberculifer, new species.
Chondrodesmus alidens, new species.
Schistides atopophallus, new species.
Holistophallus peregrinus Silvestri.
Sphaeriodesmus hondurasanus, new species.

BRITISH HONDURAS.

None recorded.

GUATEMALA.

Platydesmus triangulifer Pocock.
Platydesmus analis Pocock.
Platydesmus marmoreus Pocock.
Platydesmus perpictus Pocock.
Platydesmus polydesmoides Lucas.
Platydesmus guatemalae Brölemann.
Desmethus setifer, new species.
Siphonophora barberi, new species.
Siphonophora fallens, new species.
Siphonophora globiceps, new species.
Prostemmiulus cooki, new species.
Cleidogona stolli Pocock.
Gymnostreptus lactus, new species.
Gymnostreptus vagans, new species.
Orthoporus discriminans, new species.
Orthoporus cobanus, new species.
Orthoporus rodriguezi (Brölemann).
Orthoporus rodriguezi coriaceus (Brölemann).
Parajulus stylifer Pocock.
Parajulus leucoclius, new species.
Rhinocricus stolli Pocock.
Rhinocricus scobinatus Pocock.
Rhinocricus obesus Brölemann.
Oxypygides mesites, new species.
Oxypygides lapidicina, new species.
Oxypyge ferruginopes, new species.
Oxypyge confusa, new species.
Oxypyge socia, new species.
Oxypyge equalis, new species.
Spirobolus hoplomerus Pocock.

Spirobolus stolli Pocock.
Spirobolus eximius Porat.
Oxobolus virilis, new species.
Oxobolus cinctus, new species.
Oxobolus eratus, new species.
Oxobolus pictus, new species.
Allopocockia tylopus (Pocock).
Spirobolellus articulus Pocock.
Arolus purulanus, new species.
Orthomorpha coarctata (Saussure).
Oxidus gracilis (Koch).
Amplinus arcatus Pocock.
Amplinus nitidus (Brölemann).
Amplinus palicaudatus (Attems).
Amplinus orphnius, new species.
Polylepiscus stolli Pocock.
Polylepiscus actaeon Pocock.
Polylepiscus heterosculptus (Carl).
Chondrodesmus montanus (Pocock).
Chondroresmus rodriguezi (Brölemann).
Cyclorhabdus contortus Brölemann.
Eutyporachis tessellatus Pocock.
Eutyporachis oltramarei (Carl).
Atylophor rafaelanus, new species.
Tunodesmus orthogonus, new species.
Tunodesmus laminiger, new species.
Synthodesmus simulans, new species.
Rhysodesmus championi Pocock.
Rhysodesmus stolli Pocock.
Rhysodesmus violaceus (Brölemann).
Curodesmus guatemalensis, new species.
Holistophallus peregrinus Silvestri.
Sphaeriodesmus coriaceus Pocock.
Sphaeriodesmus medius Carl.
Eusphaeriodesmus angustus (Pocock).
Cylionus constrictus Pocock.
Peridontodesmus flagellatus Pocock.
Cynedesmus celatus (Pocock).
Cynedesmus perparvus (Pocock).
Glomeroides centralis, new species.
Glomeridesmus centralis, new species.

Suborder COLOBOGNATHA.

Family PLATYDESMIDAE.

Genus PLATYDESMUS Lucas.

1. PLATYDESMUS TRIANGULIFER Pocock.

Platydesmus triangulifer Pocock, Biol. Centr.-Amer., Diplop., 1903, p. 45, pl. 4, figs. 4–4e.

Locality.—Guatemala: Volcan de Acatenango.

2. PLATYDESMUS ANALIS Pocock.

Platydesmus analis POCOCK, Biol. Centr.-Amer., Diplop., 1903, p. 46, pl. 4, figs. 3–3*g*.

Locality.—Guatemala: (?) Guatemala city.

3. PLATYDESMUS MARMOREUS Pocock.

Platydesmus marmoreus POCOCK, Biol. Centr.-Amer., Diplop., 1903, pp. 48, 61, fig. 3.

Locality.—Guatemala: Cholhuitz.

4. PLATYDESMUS PERPICTUS Pocock.

Platydesmus perpictus POCOCK, Biol. Centr.-Amer., Diplop., 1903, p. 47, pl. 5, figs. 1–1*j*.

Locality.—Guatemala: Senahu, Cholhuitz.

5. PLATYDESMUS INTERRUPTUS, new species.

Plate 1, figs. 1, 2.

Dorsum in general brown. A black median longitudinal band geminate with a median line which expands at intervals into quadrate areas, of which there are four, each of these bounded on each side by a quadrate black area about equal to itself in size. The surface paler in a longitudinal stripe between each two black quadrate spots and in an area laterad of each of the latter. Legs and ventral surface pale, the antennae typically darkened distad. Body very broad, three times longer than wide. Eyes present. First tergite produced forward beyond the head, thus completely covering the latter from above; the anterior border acutely notched at the middle, as shown in plate 1, figure 1. Of the two rows of tubercles on the tergites the anterior one extends laterad nearly to ends of keels, the posterior row not so far. Last tergite surpassed by keels of the preceding segment (pl. 1, fig. 2). Number of segments, mostly between 40 and 50. Length, 15 mm.: width, 5 mm.

Localities.—Honduras: San Juan Pueblo (type locality), eighteen specimens, and La Ceiba, one specimen (W. M. Mann).

Suggesting the Guatemalan *P. perpictus* Pocock, but different clearly in the color pattern, the greater width of the body, the more open median incision in the first tergite, etc.

Type.—Cat. No. 812, U.S.N.M.

6. PLATYDESMUS INTERRUPTUS SIMPLEX, new variety.

Agreeing with the preceding form closely in general structure, but differing in coloration. The dorsum has a sharply defined, narrow, evenly continuous, median, longitudinal, dorsal black stripe, else-

where brown, the half adjacent to the middorsal strip in each side paler than the ectal half.

Localities.—Honduras: La Ceiba (type locality), nine specimens, and San Juan Pueblo, one specimen (W. M. Mann).

Type.—Cat. No. 813, U.S.N.M.

7. PLATYDESMUS POLYDESMOIDES Lucas.

Platydesmus polydesmoides LUCAS, Ann. Soc. Ent. France, 1843, p. 52, pl. 3, figs. 1–8.—POCOCK, Biol. Centr.-Amer., Diplop, 1903, p. 48.

Locality.—Guatemala.

8. PLATYDESMUS GUATEMALAE Brölemann.

Platydesmus guatemalae BRÖLEMANN, Mém. Soc. Zool. France, 1909, vol. 13, p. 112, pl. 7, figs. 78–82.

Locality.—Guatemala.

9. PLATYDESMUS LANKESTERI Brölemann.

Platydesmus lankesteri BRÖLEMANN, Ann. Soc. Ent. France, 1905, p. 354, pl. 9, fig. 15.

Locality.—Costa Rica: El Reventado.

DESMETHUS, new genus.

This genus differs from *Platydesmus* in that the tergites bear numerous closely arranged and setigerous tubercles over the entire surface instead of bearing only two rows of these, but the tergites each with a similar deep transverse furrow. It also differs in the last tergite, which does not surpass the valves and does not bear the caudal series of long setiferous cones, these being replaced by more ordinary tubercles. Sternites, broad. Eyes, none.

Genotype—Desmethus setifer, new species.

10. DESMETHUS SETIFER, new species.

Plate 1, figs. 3–8.

Outer half of keels yellow. The dorsum with a pale median longitudinal stripe, each side of which is a broader dark brown band, the region between this dark band and the marginal yellow of the keels being a lighter brown due to an elongate pale area or group of light dots on each tergite. Middle region of vertex and front of head brown, the lateral portions yellow, as is also the clypeal region. Venter yellow. Antennae and legs yellow, a little infuscated distally. Body broad, five times longer than wide. Head minutely granular, bearing numerous short setae. Gnathochilarium as shown in plate 1, figure 6. The first tergite is anteriorly widely emarginate, the keels being rounded and bent forward and thus leaving the head entirely uncovered. All tergites densely covered above over their entire surfaces out to the ends of the keels with small tubercles or

broader than the keels of the preceding segment, which surpass it a little. Its caudal margin convex. Surface covered with numerous setiferous granules as with the other tergites, with six tubercles along the caudal margin bearing long setae, but these tubercles much smaller than the corresponding cones characterizing *Platydesmus*; the tergite not surpassing the anal valves which are not granular but bear numerous short setae. The sternites are also all subdensely setose. Those in the middle region very broad, the width nearly equal to the combined length of the first two joints of the legs. In going forward and backward from the middle region the sternites become progressively narrower. Legs all shortly setose.

Gonopods of male as shown in plate 1, figures 7 and 8.

Length, 16 mm.; width, 3.2 mm.

Locality.—Guatemala: San Rafael, numerous specimens (O. F. Cook, June 4, 1914).

Type.—Cat. No. 814, U.S.N.M.

Family SIPHONOPHORIDAE.

Genus SIPHONOPHORA Brandt.

11. SIPHONOPHORA BARBERI, new species.

Plate 2, figs. 1–5.

Yellow, of a usually reddish cast, with dorsum dusky and typically showing a median longitudinal black line or stripe. Head rather narrow, widest at base. Beak about equal in length to the head, a little curved. The antennae are heavy and conspicuously clavately enlarged, obviously thicker distally than at middle. The antennae exceed the beak, the latter reaching to the middle of the sixth article (see pl. 2, fig. 1). The collum is subangularly widely excised in front, sides converging forward, as shown in the figure. Pleurites of anterior and of posterior regions as shown in plate 2, figures 2 and 3.

Gonopods as represented in plate 2, figures 4 and 5.

Number of segments, 68 to 82.

Length, up to 30 mm.; the corresponding width, 1.2 mm.

Locality.—Guatemala: Jocalo, many specimens (H. S. Barber).

Type.—Cat. No. 815, U.S.N.M.

12. SIPHONOPHORA TELANA, new species.

Plate 2, figs. 6–8.

Yellow, a little dusky, the head darker.

Differs obviously from the preceding species in its more globose head and much shorter rostrum, the latter shorter than the head, but longer than in the Guatemalan *S. globiceps* Pocock (pl. 2, fig. 6).

Antennae clavate. Collum with sides nearly straight, converging cephalad. Anterior margin widely incurved, not straight, as represented for *globiceps*, as shown in the figure. Anterior and posterior pleurites as shown in plate 2, figures 7 and 8.

Number of segments, female, 94.

Length, 25 mm.

Locality.—Honduras: Tela, one female (W. M. Mann).

Type.—Cat. No. 816, U.S.N.M.

13. SIPHONOPHORA FALLENS, new species.

Plate 3, figs. 1–4.

Yellow, with a series of small, lighter spots along the side. Head subglobose, with beak very short, as in *S. globiceps*. The antennae are more evenly clavate than in the latter species, the sixth article thickest, whereas in the other form the antenna is of nearly uniform width over middle and distal sections; rather abruptly much thicker than at base (see pl. 3, fig. 1). Anterior margin of collum widely and not deeply concave, as shown in the figure. Pleurites of anterior and posterior regions as shown in plate 3, figures 2 and 3.

Gonopods as represented in plate 3, figure 4.

Number of segments, male, 55 to 60.

Length, 15 mm.

Locality.—Guatemala: Joyabaj-Chiché, six specimens (O. F. Cook, May, 1906).

Type.—Cat. No. 817, U.S.N.M.

A much smaller species than *S. globiceps*, differing in form of antennae, as well as in gonopods, etc.

14. SIPHONOPHORA GLOBICEPS Pocock.

Siphonophora globiceps Pocock, Biol. Centr.-Amer., Diplop., 1903, p. 41, pl. 5, figs. 6–6*a*.

Locality.—Guatemala: Purula, Santa Rosa, five specimens (O. F. Cook, May, 1906).

These specimens agree with the original description and figures as to form of head, beak, and antennae. They are, however, decidedly broader in proportion to length. The largest specimen is 34 mm. long and 2 mm. wide, while a specimen 18 mm. long is 1.2 mm. wide. Pocock gives his type as 21 mm. long and 1 mm. wide. The specimens in hand are also much darker in color—dusky brown. However, since Pocock had but a single specimen and the present ones are from the same locality as his, I believe there is scarcely room for doubt that they represent the same species.

15. SIPHONOPHORA PROGRESSOR, new species.

Plate 3, figs. 5–7; plate 4, figs. 1, 2.

Dusky yellow, excepting at ends, which are clearer yellow and often of a weakly ferruginous cast. Head anteriorly rounded, only slightly conical at base of beak. Sides subparallel, flaring outward at extreme base. Beak as long as head, slender (pl. 3, fig. 5). Antennae exceeding beak by their sixth and seventh articles, or nearly that amount. Second article clavately widening, the remaining portion of antennae of nearly uniform width to the small last article (pl. 3, fig. 5). Collum with sides convex; anterior margin deeply incurved at middle, as shown in the figure. Body not keeled, uniformly and very shortly pilose. Pleurites of anterior and posterior region as shown in outline in plate 4, figures 1 and 2.

Gonopods of male as represented in plate 3, figures 6 and 7.

Number of segments in female, 137 to 173. A small male, thought to be the same species, has only 99 segments.

Length, female, 60 mm.; male, 26 mm.

Locality.—Honduras: Progreso, three females and one male (W. M. Mann).

Type.—Cat. No. 818, U.S.N.M.

Superfamily STEMMIULOIDEA.

Family STEMMIULIDAE.

Genus STEMMIULUS Gervais.

16. STEMMIULUS BIOCULATUS Gervais.

Julus (Stemmiulus) bioculatus GERVAIS, Ann. Soc. Ent. France, 1844, ser. 2, vol. 2, p. 28; Ann. Sci. Nat., 1844, p. 70, pl. 5, fig. 11; Ins. Apt., 1847, vol 4, p. 200.

Stemmiulus bioculatus POCOCK, Biol Centr.-Amer., Diplop., 1909, p. 109.

Locality.—Panama: Punta Sabana, Darien.

Genus PROSTEMMIULUS Silvestri.

17. PROSTEMIMULUS RELICTUS, new species.

Plate 4, figs. 3–12.

Body blackish above, becoming paler, fulvous, down the sides and yellow ventrally; a median dorsal longitudinal fulvous stripe which expands on each tergite; a row of light spots along each side above and also one just ectad of legs. Head with two ocelli on each side, of which the lower one is proportionately larger than it is in *P. cooki*, new species (pl. 4, fig. 3). Antennae long and slender, the

sixth article about twice as long as thick (pl. 4, fig. 8). Gnathochilarium of male as shown in plate 4, figure 7. Collum with three complete longitudinal ridges below and a fourth broader one crossing only the caudal border above these (pl. 4, fig. 3). The second and the immediately succeeding tergites strongly ridged beneath, the ridging becoming weaker in going caudad. The oblique striae across metazonites on median segments extend upon dorsum, the two series almost in contact anteriorly, leaving a triangular middorsal area free from them posteriorly on each segment. Transverse sulcus sharply impressed, angulate at dorsal line.

The legs of first, second, and third pairs of male as shown in plate 4, figures 4, 5, and 6.

Gonopods of male as shown in plate 4, figures 11 and 12.

Sternites of ninth segment are represented in plate 4, figures 9 and 10.

Number of segments, 44.

Length, about 28 mm.; width, 2.2 mm.

Locality.—Honduras: La Ceiba, one male (W. M. Mann).

Type.—Cat. No. 819, U.S.N.M.

The gonopods of the specimen are broken.

18. PROSTEMMIULUS LOMBARDIAE, new species.

Plate 5, figs. 1–4.

Brown throughout, darker over dorsum, the usual two series of paler spots along each side visible under lens, but no trace of middorsal pale line. Anal segment and collum not differently colored. Legs yellowish, the antennae brown. Head with two ocelli on each side, of which the lower or anterior is much the smaller. The antennae are slender, with the sixth article nearly uniformly cylindrical, scarcely thicker distally than proximally and a little more than twice as long as thick (pl. 5, figs. 1 and 2). Collum with three longitudinal striae across ventral end, these setting off two ridges much less elevated and sharp than the corresponding ones in *relictus*. No striae above the uppermost of these three (pl. 5, fig. 1). Second tergite striate beneath. Striae on succeeding tergites rising higher and higher and first reaching the middorsal region on the twelfth segment. Papillae of last segment 3+3, as usual, the setae moderate in length.

Sternites of form shown in plate 5, figures 3 and 4.

Number of segments, 42.

Length, 12 mm.; width, 1 mm.

Locality.—Honduras: Lombardia, one female (W. M. Mann).

Type.—Cat. No. 820, U.S.N.M.

19. PROSTEMMIULUS COOKI, new species.

Plate 5, figs. 5–12.

Body in general dark brown or fuscous. A narrow, median, longitudinal stripe of fulvous or light orange color, the stripe constricted over the anterior portion of each segment. Collum and last segment also light orange in color, as is the lower part of face. Head with two ocelli on each side, of which the anterior is the smaller, as usual, but relatively larger than in, for example, the Costa Rican *P. picadoi* Silvestri (pl. 5, fig. 5). Antenna long and slender, the sixth joint about twice as long as thick. Collum typically with four longitudinal, deep striae on each side or with two complete and several shorter ones (see pl. 5, fig. 5). Second tergite deeply striate beneath, the striae on succeeding segments more numerous and extending farther dorsad, but in no case present in the median dorsal region.

The legs of first, second, and third pairs of the male as shown in plate 5, figures 6 to 8; leg of seventh segment in plate 5, figure 12.

Sternites as shown in plate 5, figures 9, 10.

Gonopods of male as represented in plate 5, figure 11.

Number of segments, 46 to 51.

Length, 28 mm.; width, 2 mm.

Locality.—Guatemala: Joyabaj, several males and females (O. F. Cook, May, 1906).

Type.—Cat. No. 821, U.S.N.M.

20. PROSTEMMIULUS TRISTANI Silvestri.

Prostemmiulus tristani SILVESTRI, Boll. Lab. Zool. Portici, 1916, vol. 10, p. 326, figs. XXXIV, 1–14.

Locality.—Costa Rica: La Estrella.

21. PROSTEMMIULUS PICADOI Silvestri.

Prostemmiulus picadoi SILVESTRI, Boll. Lab. Zool. Portici, 1916, vol. 10, p. 327, figs. XXXV, 1–4.

Locality.—Costa Rica: La Estrella.

Superfamily CHORDEUMOIDEA.

Family CRASPEDOSOMIDAE.

Genus CLEIDOGONA Cook and Collins.

22. CLEIDOGONA CEIBANA, new species.

Plate 6, figs. 1–6.

Lower part of sides, venter, and legs pale fulvous, the legs darkened distally. Upper part of sides and dorsum brown, with a series of paler areolated spots along each side. Upper part of head and

the antennae brownish over a pale background. Ocelli about 25 in five series; thus: 7, 6, 5, 4, 3. Segments with sides weakly elevated or longitudinally ridged on each side, the lateral setiferous tubercle arising from caudal end of the ridge. Caudal margin of segments gently sinuate, bulging convexly near or just below level of the lateral tubercle and concave just above and below this. In the ninth legs of the male the first joint is nearly as long as the second; it is thick proximally and bends a little and narrows just distad of the middle, being somewhat compressed in the dorsoventral direction; process on basal part small. The second joint is strongly clavate and is a little constricted near the middle. The tenth legs of the male have the usual coxal pouches, from which, in the type, conspicuous clavate processes are extruded (see pl. 6, fig. 1). The eleventh legs of the male have the usual coxal process, which is a little curved at the distal end, and the coxal pouches, which give rise to processes similar to those of the tenth legs, but smaller (pl. 6, fig. 2). The process from the sternite between the twelfth legs is large and is remarkable in being furcate anteriorly, the branches extending each side of the gonopods (see pl. 6, figs. 3 and 4).

The gonopods are represented in plate 6, figures 5 and 6.

Length, about 15 mm.

Locality.—Honduras: La Ceiba, one male (W. M. Mann).

Type.—Cat. No. 822. U.S.N.M.

23. CLEIDOGONA STOLLI Pocock.

Cleidogona stolli Pocock, Biol. Centr.-Amer., Diplop., 1903, p. 52, pl. 5, figs. 8–8c.

Locality.—Guatemala: Volcan de Agua.

Superfamily NANNOLENOIDEA.

Family NANNOLENIDAE.

Genus EPINANNOLENE Brölemann.

24. EPINANNOLENE PITTIERI Brölemann.

Epinannolene pittieri Brölemann. Ann. Soc. Ent. France, 1903. vol. 72, p. 136, pl. 50, figs. 3–7.

Locality.—Cocos Island.

25. EPINANNOLENE BICORNIS Brölemann.

Epinannolene bicornis Brölemann, Ann. Soc. Ent. France, 1905, vol. 74, p. 356, pl. 9, fig. 16.—Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 107.

Locality.—Costa Rica: Cariblanco.

Superfamily SPIROSTREPTOIDEA.

Family SPIROSTREPTIDAE.

Genus GYMNOSTREPTUS Brölemann.

26. GYMNOSTREPTUS LAETUS, new species.

Plate 6, figs. 7–9.

Dorsally the prozonite and anterior portion of metazonite olive or in part of a somewhat bluish tinge, the posterior part of metazonite banded with reddish brown or ferruginous. Legs light reddish yellow. Sulcus present across vertex of head. Head with irregularly impressed lines on each side adjacent to collum. Eyes transversely elongate, angled at mesal ends. Ocelli in six series, as 11, 10, 9, 7, 5, 3. Collum not inflexed beneath, the lower anterior corner less rounded than the lower posterior, the inferior margin weakly convex. Above lower margin a series of four striae, the limiting ridges of which end at the anterior marginal thickening, and typically a short stria between second and third that does not extend forward to the middle, or with three striae above and two or three shorter ones below them (pl. 6, fig. 7). The segments in general have the metazonites dorsally strongly punctate and further roughened with intervening anastamosing rugae. Prozonites also densely punctate, but the punctae smaller on the average and the rugae less developed. Metazonites longitudinally striate below pore, with the upper striae short, not extending far from sulcus. Pore small, well removed from sulcus. Anal tergite strongly roughened with punctae and a close network of rugae, without distinct transverse furrow. Anal valves exceeding the tergite; borders strongly compressed and elevated. Anal sternite or scale short and broad, the caudal side very obtusely angled (pl. 6, fig. 8).

Gonopods of male as shown in plate 6, figure 9.

Length, about 78 mm.; width, 5 mm.

Locality.—Guatemala: Joyabaj, one male and two females (O. F. Cook, May, 1906).

Type.—Cat. No. 823, U.S.N.M.

May readily be distinguished from *vagans* in having the tergites strongly punctate as well as rugose instead of being rugose only, in the greater distance of the segmental sulcus from the pore, in the different form of the collum, and in the structure of the gonopods.

27. GYMNOSTREPTUS VAGANS, new species.

Plate 6, fig. 10; plate 7, fig. 1.

The general color is grayish brown, with a caudal band of ferruginous. Legs fulvous. Head smooth. Sulcus present only across vertex. Eyes acutely angled at mesal ends, separated from each other

by a little more than their greatest diameter (once and a sixth); ocelli in six transverse, curving series, as 12, 11, 9, 7, 6, 3. Collum angled below on each side, corner behind angle obliquely excised and the anterior corner widely excised. Above lower angle a series of five longitudinal ridges uniting with the elevated margin anteriorly. The lower angle not inflexed (pl. 6, fig. 10). Segmental furrow deeply impressed across dorsum, its anterior face or wall subvertical, its posterior one widely slanting. Surface caudad of furrow roughened with densely arranged anastamosing rugae or ridges, which are chiefly longitudinal and part of which cross the furrow to its anterior edge. Surface in front of furrow similarly roughened, but the ridges much finer. Metazonite deeply striate below, the striae defined by ridges. Covered portion of prozonites marked with transverse encircling striae, as usual. Pores beginning on sixth segment. Last tergite caudally obtuse, much exceeded by the valves. Surface roughened with a dense network of fine rugae and crossed between caudal end and middle by a transverse furrow, a smaller furrow occurring also near the end. Mesal borders of anal valves strongly compressed and elevated, in profile weakly convex. Anal scale short and broad, caudally very obtusely angular, the surface densely punctate.

The gonopods as shown in plate 6, figure 1.

Number of segments, 59.

Length, 80 mm.; width, 5 mm.

Locality.—Guatemala: Candalaria Rocks, Scamay Estuary, one male, June, 1904; Trece Aguas, one lighter colored male, taken July, 1907.

Type.—Cat. No. 824, U.S.N.M.

28. GYMNOSTREPTUS PACIFICUS, new species.

Plate 7, figs. 2–4.

Olive, the caudal borders of segments ringed with fulvous or fulvo-ferruginous. Legs reddish brown. Head smooth and shining. The usual sulcus across vertex distinct. Eyes angled at mesal end. a little more than their diameter (about once and a sixth) apart. Ocelli in six or seven series, as 12, 11, 9, 7, 6, 4, 1. Collum a little inflexed below, with lower inferior corner moderately produced, in the male apically rounded. Above lower end with seven or eight striae, of which the uppermost is deepest, the others decreasing in depth or height of limiting ridge in going ventrad. The number of striae in the female fewer—five or six (pl. 7, figs. 2 and 3). Metazonites covered dorsally with a dense, close network of rugae, with meshes punctiform or but little elongate. Prozonites without distinct rugae, but punctate, the punctae fine. Pores small, remote from the sulcus,

but clearly in front of middle of metazonite. Striae immediately below pore weaker and incomplete. Anal tergite not covering valves, obtusely rounded behind; surface densely reticulo-rugose and punctate, with a shallow transverse depression in front of caudal end. Valves with margins compressed and elevated; surface densely finely punctate. Anal sternite very obtusely angled behind, wide, and short.

Gonopods shown in plate 7, figure 4.

Number of segments, 65 to 69.

Length, up to about 100 mm.; width, from 5 to 6 mm.

Locality.—Costa Rica: Santo Domingo de San Mateo, several males and females (W. R. Maxon, May 16, 1906).

Type.—Cat. No. 825, U.S.N.M.

May be distinguished from *G. laetus* in not having the rugae so sharply defined and not so dominantly longitudinal, as well as in the clearly different form of the gonopods. It is a larger and darker form, with legs dark reddish brown instead of light yellowish.

Genus ORTHOPORUS Silvestri.

29. ORTHOPORUS ABSCONSUS, new species.

Plate 7, figs. 5–8.

General color fuscous, with the paler annuli in the type not pronounced. A fine sulcus across vertex joining a transverse line between angles of eyes. No median sulcus below. The frontal and clypeal region roughened with coriarious impressions. Eyes separated by their longer diameter; mesal angle acute. Collum not truly inflexed below; on each side with six or seven striae, of which the uppermost is limited below by a pronounced ridge, the others with limiting lower edges weaker (pl. 7, fig. 5). Dorsal region of segments in general densely and strongly punctate, both in front of and behind the sulcus, the latter cross ribbed. Striae on sides and below sharply impressed across metazonite. Anal tergite not covering the valves; obtusely angled behind; surface densely coarsely punctate and puncto-rugose. The valves similarly roughened. Anal scale as shown in plate 7, fig. 6.

Most readily recognized by form of gonopods, as represented in plate 7, figures 7 and 8.

The number of segments is uncertain, as the type was broken into pieces mingled with those of other specimens; but it is probably near 69.

Width, 4 mm.

Locality.—Costa Rica: Santo Domingo de San Mateo, Pacific side, one male in vial with specimens of *G. laetus* (W. R. Maxon).

Type.—Cat. No. 826, U.S.N.M.

30. ORTHOPORUS DISCRIMINANS, new species.

Plate 8, figs. 1–4.

Body with the usual alternating bands, these of bluish tinge and brown or ferruginous, the bands of latter color about caudal region of segments. Legs reddish brown. Sulcus on head present only across vertex, weak, its anterior end lying in a depression. Head smooth. Eyes their longer diameter apart. Collum not inflexed below, the lower end on each side of the usual general form. Above margining sulcus three deep sulci limited each by a ridge below it (pl. 8, fig. 1). Segments in general minutely punctate in front of segmental sulcus dorsally, behind sulcus more coarsely punctate and with anastamosing rugae, particularly on more posterior portions, these fading out toward sulcus. The rugae less sharply defined than in, for example, *laetus*. Striate below level of pore, with the uppermost striae short and weaker. Anal tergite not covering the valves, rounded caudally; crossed in front of caudal end by a transverse depression or furrow; surface densely punctate, also with a network of weak, fine rugae. Valves punctate. Anal sternite broadly triangular, the apical angle obtuse (pl. 8, fig. 2).

Gonopods of male as shown in plate 8, figures 3 and 4.

Number of segments, near 56.

Length, about 65 mm.; width, 4 mm.

Locality.—Guatemala: Pancajche, one male, June, 1904.

Type.—Cat. No. 827, U.S.N.M.

Characterized by sculpturing and particularly by the form of the gonopods, the large process at distal end of the anterior pair extending cephalad of ectad across telopodite of posterior pair being a readily noted distinctive feature.

31. ORTHOPORUS COBANUS, new species.

Plate 8, figs. 5–7.

Segments each of a somewhat bluish brown color anteriorly and with a caudal, rather broad band of more reddish brown or ferruginous color, or sometimes fulvous, this caudal band often also encroaching on the prozonite of succeeding segment. Anal segment dark. Legs dark reddish brown. Head smooth. Sulcus present only on vertex, rather weak. The eyes small and widely separated, being twice their diameter apart. Ocelli in five series, as 9, 8, 7, 5, 2. Collum truncate at each end below, both the anterior and the posterior angles obtuse, the latter the more rounded. Above lower margin three long striae curving upward anteriorly and, typically, a short one above and one below the lowermost of these (pl. 8, fig. 5). Sulcus of segments deeply impressed throughout, over dorsum

crossed by fine and well separated ridges or ribs. Dorsal surface behind the sulcus densely punctate, in part with an obscure network of obsolete fine ridges. Longitudinal striae on metazonite begin just below the pore, the two or three uppermost of these on segments in middle region being short, the others complete. Dorsum in front of sulcus more finely punctate, the punctae disappearing anteriorly. Pores beginning on sixth segment, each well removed from the sulcus. Last tergite obtuse and rounded caudally, exceeded by the valves, densely finely punctate. Valves with mesal margins moderately compressed and elevated. Anal scale triangular, wider than long, the caudal angle rounded.

Gonopods as shown in plate 8, figures 6 and 7.

Number of segments in male, 63.

Length, about 57 mm.; width, 4.5 mm.

Localities.—Guatemala: Coban-Tache (type locality), two males and a female, May, 1904; Coban, coffee plantation, two males and a female, May, 1904; Sepaiuite, one female, May, 1904; Secanquim, several females of mostly larger size (G. P. Goll, December, 1905); Joyabaj, several males and females, May, 1906; Trece Aguas, one male, June, 1907.

Type.—Cat. No. 828, U.S.N.M.

32. ORTHOPORUS CONFRAGOSUS (Karsch).

Spirostreptus confragosus KARSCH, Zeits. Ges. Naturw., 1881, ser. 3, vol. 6, p. 44.

Spirostreptus (Scaphiostreptus) confragosus BRÖLEMANN, Ann. Soc. Ent. France, 1905, vol 74, p. 367, pl. 9, fig. 20; pl. 10, fig. 21.

Orthoporus confragosus POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 101.

Locality.—Costa Rica: San José.

33. ORTHOPORUS FESTAE (Silvestri).

Plusioporus festae SILVESTRI, Boll. Mus. Torino, 1896, vol. 11, No. 254, p. 3.

Orthoporus festae POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 102.

Locality.—Panama: Isthmus of Darien, Punta Sabana.

34. ORTHOPORUS RODRIQUEZI (Brölemann).

Spirostreptus rodriguezi BRÖLEMANN, Mém. Soc. Zool. France, 1900, vol. 13, p. 104, pl. 6, fig. 47; pl. 7, fig. 58.

Orthoporus rodriguezi POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 103.

Locality.—Guatemala.

35. ORTHOPORUS RODRIQUEZI CORIACEUS (Brölemann).

Spirostreptus rodriguezi coriaceus BRÖLEMANN, Mém. Soc. Zool. France, 1900, vol. 13, p. 106.

Orthoporus rodriguezi, var. *coriaceus* POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 103.

Locality.—Guatemala.

Genus DIAPORUS Silvestri.

36. DIAPORUS CULEBRAE, new species.

Plate 8, figs. 8, 9; plate 9, fig. 1.

Brown or olive brown about caudal and cephalic borders of segments, with the middle band ferrugino-testaceus. Collum olive brown, with borders bright ferrugino-testaceus. Legs a somewhat reddish yellow. Head smooth, with sulcus across vertex fine. Eyes angled at mesal end, about once and a third their longer diameter apart. Ocelli in six or seven series, as 11, 11, 10, 9, 5, 2. Collum moderately inflexed below, the inflexed portion limited above by a strong ridge, which is swollen into a large rounded tubercle at the caudal edge and curves mesad anteriorly, fading out toward dorsum. Below and parallel with this ridge are five or six deep striae (pl. 8, fig. 8). Segments with the encircling sulcus deep and complete. Surface in general densely but finely punctate, at most weakly or obscurely rugose. Striate beneath and on lower part of sides, the striae not extending up to level of pore, or with a few short striae between pore and uppermost complete stria. The anal tergite very obtusely angled behind; the caudal end abruptly depressed and sharply set off from the main part of plate; surface densely punctate and a little roughened with a fine network of weak or obscure rugae. The anal valves exceeding the tergite; mesal borders compressed and elevated; densely finely punctate. Anal sternite very wide and short, the caudal margin nearly straight, being only slightly angled at the middle (pl. 8, fig. 9).

The gonopods of the male most resemble those of *D. chiriquensis* (Pocock); but the telopodite of the anterior pair does not have the terminal portion crescentic, the distal process long, and the distal end of the posterior gonopod is different in form (pl. 9, fig. 1).

Number of segments, 57.

Length, about 67 mm.; width, 5 mm.

Locality.—Panama: Culebra, Canal Zone, one male (W. M. Wheeler, November, 1911).

Type.—Cat. No. 5,016, M.C.Z.

37. DIAPORUS PALMENSIS (Brölemann).

Spirostreptus (Scaphiostreptus) typotopyge palmensis Brölemann, Ann. Soc. Ent. France, 1905, vol. 74, p. 362, pl. 9, fig. 18.

Orthoporus palmensis Pocock, Biol. Centr.-Amer. Diplop., 1909, p. 96.

Locality.—Costa Rica: La Palma.

38. DIAPORUS CHIRIQUENSIS (Pocock).

Orthoporus chiriquensis Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 97, pl. 8, fig. 2.

Locality.—Panama: Volcan de Chiriqui.

39. DIAPORUS OMALOPYGE (Brölemann).

Spirostreptus (Scaphiostreptus) omalopyge Brölemann, Ann. Soc. Ent. France, 1905, vol. 74, p. 365, pl. 9, fig. 19.
Orthoporus omalopyge Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 103.

Locality.—Costa Rica: La Palma, Carillo, Caché.

40. DIAPORUS TYPOTOPYGE (Brölemann).

Spirostreptus (Scaphiostreptus) typotopyge Brölemann, Ann. Soc. Ent. France, 1905, vol. 74, p. 359, pl. 9, fig 17.
Orthoporus typotopyge Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 95.

Localities.—Costa Rica: La Palma; Sururbres, near San Mateo; Caché, Cariblanco.

Superfamily JULOIDEA.

Family PARAJULIDAE.

Genus PARAJULUS Humbert and Saussure.

41. PARAJULUS STYLIFER Pocock.

Parajulus stylifer Pocock, Biol. Centr.-Amer., Diplop., 1903, p. 57, pl. 5, figs. 11, 11*a*.

Locality.—Guatemala.

42. PARAJULUS LEUCOCLIUS, new species.

Plate 9, figs. 2–8.

General color fuscous, of bluish cast, paler around caudal border of each segment. Collum and the three following tergites and the lower and lateral portions of head fulvous, contrasting sharply with the following region of body, these lighter tergites under lens showing a network of dark lines. Anal valves and at least the lateral region of preceding one or two tergites also fulvous. Small dark spots (over repugnatorial glands) visible along sides, at least in posterior region. Segmental suture deeply impressed, slightly excurved opposite core, the curving portion long. Pore on middle segments at least its diameter from the suture. Anal tergite produced much beyond the valves, straight to the slender tip, which is distally slightly curved upward (pl. 9, figs. 3, 4). In the male the cardo of the mandible is broadly produced and extends in two angles, as shown in plate 9, figure 2. The collum of the male is long, as usual. Both lower angles are well rounded, but the anterior one more widely so than the posterior. Above the margin are two longitudinal striae, of which the upper one is the more distinct (pl. 9, fig. 2). First legs of male strongly swollen, the tibia flattened on mesal side. much broader than the femur, its anterior side convex, its caudal side straight. Penult segment much more slender, narrowing distad. Second legs of male with median processes, as shown as

plate 9, figure 5. The anterior gonopods have the inner processes unusually broad proximally, narrowing distally, the ectodistal angle rounded, and the mesodistal one acute. Posterior gonopods as shown in the figures (see pl. 9, figs. 6–8).

Number of segments 42 to 46.

Length, 25 mm.

Locality.—Guatemala: Actele, two males and a young female (O. F. Cook, May 2, 1906); Tectic, Santa Rosa, two females (O. F. Cook, 1906).

Type.—Cat. No. 829, U.S.N.M.

Superfamily SPIROBOLOIDEA.[1]

Genus RHINOCRICUS Karsch.

43. RHINOCRICUS NICARAGUANUS, new species.

Plate 9, figs. 9–11.

Anterior region of segments light olive, with a pinkish band just back of suture and the caudal border banded with deep red or reddish black. Collum olive, with anterior and posterior borders deep red. Legs fulvous. Head smooth. Sulcus widely interrupted in frontal region, the upper end of its lower division lying in a depression. Sensory cones of antennae very numerous. Collum smooth, widely rounded below. Second tergite extending much below level of collum, not excavated, the anterior edge beneath collum oblique. Sulcus complete. Sulci on following tergites also complete, but becoming obscure on the last several segments, a little curved opposite the pore, which is well removed. Tergites smooth and shining, striate only beneath. Scobina with anterior impression transversely elliptic, the posterior striate area pointed behind, the scobina widely separate from each other (pl. 9, fig. 11). Anal tergite bluntly rounded behind, much exceeded by the valves. Anal sternite short and wide, broadly trapeziform, the caudal margin straight, the posterior angle rounded (pl. 9, figs. 9, 10).

Number of segments, 43.

Length, 100 mm.; width, 12 mm.

Locality.—Nicaragua: Chontales Camoapa, one female (W. R. Richardson).

Type.—Cat. No. 5,017, M.C.Z.

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[1] The family names under Spiroboloidea have been purposely omitted because of the present unsettled classification, due largely to lack of detailed morphological knowledge of a considerable number of genera.

44. RHINOCRICUS WHEELERI, new species.

Plate 10, figs. 1–3.

Black above, fulvous over lower part of sides and venter. Legs yellow. Head smooth. The sulcus continuous across vertex and down to labral margin. Collum without striae excepting a fine longitudinal one at level of eye on each side, extending across anterior border only.

This form differs from other Central American species in having an anterior or secondary suclus deeply impressed across dorsum, whereas the primary sulcus is obliterated above. The secondary sulcus takes its origin above the pore and lies in front of the level of the latter. In this respect it is like the Mexican *R. omilteme* Pocock, but may be distinguished from the latter in having the scobina present back as far as the thirty-sixth segment instead of ceasing at the fifteenth. The scobina consist of a deeply impressed concentric pit at the anterior edge, followed by a posteriorly pointed area of fine cross striae. Sides of segments obliquely striate below level of pore, as usual, the uppermost of these striae curving dorsad in front of the pore.

Anal tergite obtuse behind, the angle rounded, exceeded by the valves. Valves compressed moderately, but not margined. Anal scale triangular, the caudal angle narrowly rounded (see pl. 10, figs. 1, 2).

In the form of the telopodite of the posterior gonopods also suggesting *R. omilteme*, but this longer. and the branches differing in form, as represented in plate 10, figure 3.

Number of segments, 43 to 45.

Length, 42 mm.; width, 3.5 mm.

Locality.—Costa Rica: Port Limon, three specimens (W. M. Wheeler, November, 1911).

Type.—Cat. No. 5,018, M.C.Z.

45. RHINOCRICUS CENTRALIS, new species.

Plate 10, figs. 4–6.

Segments olive brown, encircled caudally with band of reddish brown or rust color. Legs yellow. Head smooth. Sulcus sharply impressed, interrupted in frontal region. Antennae with sixth joint large, the last bearing very numerous sensory cones. Collum widely rounded below. A margining sulcus below, which extends a short distance up the anterior border. Surface with coriarious impressed lines, which are coarser and more numerous at level of eye and a little below it on each side, where the surface is typically depressed. Sec-

ond tergite as in *nicaraguanus*, or nearly so. Sulcus obscure in mid-dorsal region. The tergites in general smooth, with striae only beneath. Sulcus complete, but not deep across dorsum. The scobina with anterior impression widely and narrowly elliptic; the striate area wider anteriorly than the elliptic impression, narrowing caudad. Scobina present back to the fifth or sixth segment from caudal end, but the most posterior ones lacking the anterior impression. Caudal process of last tergite acute in general outline, but rounded at end. The anal valve broadly subtrapeziform, but the caudal side very obtusely angular, thus giving in reality five sides (see pl. 10, fig. 4).

Gonopods as shown in plate 10, figures 5 and 6.

Number of segments in male type, 45.

Length, about 88 mm.; width at middle 11 mm., at penult segment 7 mm., anteriorly 9.5 mm.

Locality.—Costa Rica, one male (Bergdorf and Schild), Acc. 38, 962.

Type.—Cat. No. 830, U.S.N.M.

Resembles *R. tristani* Pocock, but differs in larger size, coloration, form of telopodite of posterior gonopods, and in form of scobina.

46. RHINOCRICUS SIMULANS, new species.

Plate 10, figs. 7–10.

Through long preservation with drying the type does does not show the original coloration clearly. It seems, however, to have been a shade of olive, with a caudal ferruginous border on each segment narrower than that of *centralis*. Legs and antennae yellowish. Sensory cones of antennae numerous. Ocelli in six transverse series in each eye, about 32 in number. The collum of the usual general form, smooth. Margining sulcus not extending at all up anterior margin. Second tergite produced below, as in the preceding species. The sulcus obscure dorsally. Sulcus on the following tergites complete. Surface smooth, with the usual striation beneath. Scobina formed nearly as in *centralis* (see pl. 10, fig. 8); present back to eighth from last segment. The anal tergite extending over valves above, or nearly so. The last sternite differing conspicuously from those of the preceding two species in being strictly triangular, the sides straight, or nearly so, and meeting in a slightly obtuse angle behind (pl. 10, fig. 7).

Gonopods as shown in plate 10, figures 9 and 10.

Number of segments, 45.

Length, about 85 mm.; width, 10 mm.

Locality.—Costa Rica (C. Bergdorf and P. Schild), U.S.N.M. Acc. 38,962.

Type.—Cat. No. 831, U.S.N.M.

47. RHINOCRICUS STOLLI Pocock.

Rhinocricus stolli POCOCK, Biol. Centr.-Amer., Diplop., 1907, p. 62, pl. 6, fig. 2.

Localities.—Guatemala: Cholhuitz; Coban, Samac coffee plantation, one male (O. F. Cook, May, 1904).

The type was a female from Cholhuitz.

48. RHINOCRICUS ROGERSI Pocock.

Rhinocricus rogersi POCOCK, Biol. Centr.-Amer., Diplop., 1907, p. 61, pl. 5, figs. 12–12*b*.

Locality.—Costa Rica.

49. RHINOCRICUS APOSEMATUS Pocock.

Rhinocricus aposematus POCOCK, Biol. Centr.-Amer., Diplop., 1907, p. 63, pl. 6, figs. 4–4*e*.

Locality.—Costa Rica: Santa Clara.

50. RHINOCRICUS TRISTANI Pocock.

Rhinocricus tristani POCOCK, Biol. Centr.-Amer., Diplop., 1907, p. 63, pl. 6, figs. 5*a*–5*d*.

Locality.—Costa Rica: Santa Clara.

51. RHINOCRICUS RIXI Pocock.

Rhinocricus rixi POCOCK, Biol. Centr.-Amer., Diplop., 1907, p. 64, pl. 6, figs. 6*a*–6*e*.

Locality.—Nicaragua: Chontales copper mine.

52. RHINOCRICUS SCOBINATUS Pocock.

Rhinocricus scobinatus POCOCK, Biol. Centr.-Amer., Diplop., 1907, p. 65, pl. 6, figs. 9–9*e*.

Locality.—Guatemala: Retalhuleu.

53. RHINOCRICUS MARCI Pocock.

Rhinocricus marci POCOCK, Biol. Centr.-Amer., Diplop., 1907, p. 66, pl. 6, fig. 11.

Locality.—Nicaragua: San Marcos.

54. RHINOCRICUS FERRUGINEUS (Daday).

Spirobolus ferrugineus DADAY, Term. füzetek, 1889, vol. 12, p. 130.
Rhinocricus ferrugineus POCOCK, Biol. Centr.-Amer., Diplop., 1907, p. 70.

Locality.—Panama.

55. RHINOCRICUS HAGEDUSSII (Daday).

Spirobolus hagedussii DADAY, Term. füzetek, 1889, vol. 12, p. 130

Locality.—Panama.

56. RHINOCRICUS OBESUS Brölemann.

Rhinocricus obesus BRÖLEMANN, Mém. Soc. Zool. France, 1900, p. 107, pl. 7, figs. 59–65.

Locality.—Guatemala.

57. RHINOCRICUS COSTARICENSIS Brölemann.

Rhinocricus costaricensis BRÖLEMANN, Ann. Soc. Ent. France, 1905, p. 375, pl. 10, figs. 26–28.

Locality—Costa Rica: Cariblanco.

58. RHINOCRICUS NODOSICOLLIS Brölemann.

Rhinocricus nodosicollis BRÖLEMANN, Ann. Soc. Ent. France, 1905, p. 372–374.

Locality.—Costa Rica: Cariblanco.

59. RHINOCRICUS OCRACEUS Brölemann.

Rhinocricus ocraceus BRÖLEMANN, Mém. Soc. Zool. France, 1900, p. 124, pl. 8, figs. 115–119.

Locality.—Isthmus of Panama: Obispo.

60. RHINOCRICUS BIOLLEYI Brölemann.

Rhinocricus (*Eurhinocricus*) *biolleyi* BRÖLEMANN, Ann. Soc. Ent. France, 1903, p. 132, pl. 50, figs. 1–6; 1904, p. 371, pl. 10, fig. 22.

Localities.—Costa Rica: San José, Caché; Cocos Island.

61. RHINOCRICUS PLESIUS Chamberlin.

Rhinocricus plesius CHAMBERLIN, Trans Amer. Ent. Soc., 1914, vol. 40, p. 187, pl. 2, fig. 2.

Locality.—Costa Rica: Rio Oro Valley, near Caché.

62. RHINOCRICUS MUCRONATUS Brölemann.

Rhinocricus mucronatus BRÖLEMANN Bull. Soc. Ent. France, 1911, p. 120.

Locality.—Costa Rica: Caché.

OXYPYGIDES, new genus.

Differing from *Oxypge* in having a prominent ridge on corner of second tergite below and a deep and characteristic pit caudad of the mesal end of this ridge; also in having the anal tergite rounded behind instead of acute, this exceeded by the anal valves. Processes of anal valves remote from edge of tergite instead of in contact with it. The anterior impressions of the scobina are wide in all the known species.

Genotype.—*Oxypygides mesites*, new species.

This and related genera may conveniently be placed in a group Oxypyginae, characterized superficially by having a prominent, acute, caudally directed process from each anal valve. All have the collum widely, semicircularly rounded below, and all ordinary segments from the second caudad with deeply impressed and complete segmental sutures. In the known species scobina are present on all but the first few and the last few segments, and the gonopods are of the general pattern of those of *Rhinocricus*.

63. OXYPYGIDES MESITES, new species.

Plate 10, figs. 11, 12; plate 11, figs. 1, 2.

The segments are black above, or nearly so, caudad of the suture and lighter, fulvous to chestnut, in front of it, the dark color fading out down the sides in the male type, but not so much so in the large female paratype. Head smooth. Sulcus distinct across vertex and below, but obsolete at upper level of antennae. Distal joint of antennae with four sensory cones. Collum widely rounded below in the ordinary manner. A distinct sulcus above lower margin on caudal half, but this not extending to anterior corner. Second tergite produced below the collum. On its ventral, horizontal portion a submarginal ridge runs mesocaudad from the anterior corner. The furrow on caudal side of this ridge ends mesally in a deep pit. Segmental sulcus represented on lower part of side by a somewhat pitted or cross-marked furrow, behind which the segment is longitudinally straight, the furrow continuing as a clearly defined sulcus entirely across dorsum. On the following segments the sulcus is also complete and sharply defined. Striae are present only below. The pore is contiguous with the sulcus, which is not at all excurved at its level. The scobina are of characteristic form. The deep anterior impression of each is very wide, the two being separated by but little more than their width, but becoming smaller in going caudad. The posterior region of scobina short, being only about twice as long as the anterior impression, narrowed caudad. The scobina are present back to about the fifth segment from the caudal end. Anal tergite obtusely angular behind, exceeded by the valves, depressed transversely across middle of length. Anal valves moderately compressed, produced at upper angles of mesal borders into the usual pointed processes; these weakly curved and well removed from the tergite (pl. 10, fig. 11).

Anal scale as shown in plate 10, figure 12.

Gonopods as represented in plate 11, figures 1 and 2.

Number of segments, about 50.

Length, about 75 mm.; width, 6.8 to 7 mm.

Locality.—Guatemala: Cacao, a male and two females, April, 1906 (probably collected by O. F. Cook).

Type.—Cat. No. 832, U.S.N.M.

64. OXYPYGIDES LAPIDICINA, new species.

Plate 11, figs. 3–7.

Segments black in front of the suture, behind which they are ferruginous or ferrugino-fulvous, with border commonly paler. Legs and antennae brown. Head smooth and shining, a few very fine oblique striae on each side of vertex and frons. Sulcus distinct across vertex and down clypeus, interrupted in frontal region. The collum is widely rounded below in the usual manner. A margining sulcus below and usually a little way up the caudal corner, but not extending about the anterior corner. Second tergite extending much below level of collum, as in *mesites*. A prominent ridge extends from the anterior lower corner ventrad and then caudomesad on ventral surface, a deep pit lying caudad of its mesal end. Segmental sulcus deep entirely across dorsum, passing below on each side into a shallow furrow marked with impressed pits and short lines. Segments in general striate only ventrally. Sulcus deep and continuous across dorsum, as well as down sides, straight opposite pores. The pores high up. Scobina with anterior impression wide and weakly curved, the ends not bent back, the indicated outline narrowly elliptic; the striate posterior portion short, scarcely exceeding the anterior part (pl. 11, fig. 5). The anal tergite bluntly rounded behind, much exceeded by the valves. Anal valves with mesal margin strongly elevated. The caudal process well removed from caudal end of tergite, rather short, distally narrowly rounded (pl. 11, fig. 3).

Anal scale as shown in plate 11, figure 4.

Gonopods of male much shorter and smaller than in *mesites*, not or but little extruded and not crossing each other. Telopodite of form very different from that of genotype (pl. 11, figs. 6 and 7).

Number of segments, 52 to 54.

Length, male, 53 mm.; width, 5.5 mm.

Locality.—Guatemala: Candalaria Rocks, Scamay Estuary, one adult male and an immature male and female (O. F. Cook, June, 1904).

Type.—Cat. No. 833, U.S.N.M.

Two other females from the same locality may be the same species, apparently differing in no respect excepting in materially greater size, the length of the larger of the two being 83 mm., with a width of 8.5 mm. A similarly large female agreeing with these two was taken at Semacoch, Guatemala, by G. P. Goll, April, 1905.

Genus OXYPYGE Silvestri.

65. OXYPYGE VARICOLOR Silvestri.

Oxypyge varicolor SILVESTRI, Bull. Mus. Torino, 1896, vol. 11, No. 254, p. 4.

Locality.—Panama: Isthmus of Darien, Punta Sabana, and forest near Lago de Pita.

66. OXYPYGE FERRUGINIPES, new species.

Plate 11, figs. 8–12.

On each typical segment the color in front of the suture is from olive black to blue, the latter color more evident ordinarily toward the border, while behind the suture, dorsally, the color is olive black, running into brown, and then fulvous caudally, while below the pore the fulvous color extends forward to the suture and tends to be more ferruginous, excepting along the caudal border. Legs ferruginous. Anal tergite and valves olive black, excepting the caudal borders of the former and the mesal borders and caudal processes of the latter, which are ferruginous. Head smooth and shining. The sulcus widely interrupted at middle, the upper end of the lower section of sulcus more deeply impressed, beginning in a punctiform impression. Ocelli in the usual circular patch, not sharply differentiated. Antennae with four sensory cones. The collum evenly rounded below, the anterior margining sulcus extending entirely across the lower end and about the anterior corner, the border narrowing caudad. The second tergite extending a little below level of collum. The horizontal ventral portion strongly striate, with the striae bending out transversely on anterior portion as in *socius*, as in which also there is no trace of the prominent ridge and pit characteristic of species of *Oxypygides*. Segmental sulcus complete, not pitted. Only one or two longitudinal striae visible on side below in lateral view of the segment. On the following segments the segmental sulci are similarly complete and strongly marked, a little and narrowly curved about the caudal side of the pore, which is there contiguous with it. The scobina are larger than in *socius*, but much smaller than in *Oxypygides mesites* and are less than twice their width apart on the middle segments of the body. The striate area is not fully as long as the width of the anterior impression, equaling the latter in width anteriorly, but narrowing caudad, its caudal end rounded (see pl. 11, fig. 10). Scobina present back to about fourth from last segment, inclusive. The anal tergite is long and acutely pointed behind, the tip a little decurved and surpassing the valves exclusive of the processes. Processes of valves at extreme upper angle, as usual upcurved at tip. Valves with mesal borders

sharply differentiated and elevated, subvertically wrinkled or furrowed over middle portion (pl. 11, fig. 8).

Anal scale is shown in plate 11, figure 9.

Gonopods as represented in plate 11, figures 11 and 12.

Number of segments, 50.

Length, about 50 mm.; width, 4 mm.

Locality.—Guatemala: Cacao, two males (O. F. Cook, April, 1906).

Type.—Cat. No. 834, U.S.N.M.

67. OXYPYGE CONFUSA, new species.

Plate 12, figs. 1, 2.

Coloration as described for *ferruginipes*, but with the ferruginous bands of the segments beneath apparently more pronounced.

The structure throughout closely approximating that of the preceding species. The two forms are most readily to be distinguished from each other by differences in the scobina. On a segment of the middle region the scobina are farther removed from the anterior margin, and the anterior impressions are much narrower and more strongly curved, the ends more reflexed, and the area they limit much less narrowly elliptic in the present species than in *ferruginipes*. They are about twice their diameter apart (see pl. 12, fig. 1). The anal tergite and valves are similar, but the valves are less compressed, the border less elevated and less sharply set off, and they are wholly smooth, whereas in *ferruginipes* each one is conspicuously subvertically wrinkled across its middle region.

Unfortunately the posterior gonopods have been broken off in the type. The median plate of the anterior gonopods, etc., is shown in plate 12, figure 2.

Number of segments, 56.

Length, about 58 mm.; width, 5 mm.

Locality.—Guatemala: Cacao, one male (O. F. Cook, April, 1906).

Type.—Cat. No. 835, U.S.N.M.

68. OXYPYGE SOCIA, new species.

Plate 12, figs. 3–6.

This form is also black above, but the dark color covering entire segment excepting a narrow plate caudal border. Below the pore the dark color does not extend caudad of the suture, the posterior portion being brown or fulvous. Anal valves dusky fulvous, lighter on caudal borders. Legs lighter fulvous or a little ferruginous. Head smooth. Sulcus widely interrupted in the middle. Antennae with four sensory cones. Ocelli in a subcircular patch, as in the preceding species. Collum evenly rounded below, on each side a short longitudinal sulcus just above lower margin, this at anterior corner, not

behind middle, as it is, for example, in *O. mesites.* The second tergite only slightly produced below lower level of collum. Its horizontal ventral portion strongly striate, with some of the striae bending outward to the anterior corner on its anterior portion, but with no ridge or pit. Sulcus deep and complete, not pitted below. A few longitudinal sulci behind this sulcus on lower part of sides. On the following tergite the segmental sulcus is also deep and complete, curved opposite the pore which is close to it. The scobina contrast sharply with those of *mesites*, etc., of the preceding genus, the anterior impressions deep, crescentic, separated by four or five times their diameter; the posterior portion of scobina narrower than the anterior impression (see pl. 12, fig. 3). Scobina present back to fifth segment from last, inclusive. Anal tergite longer than in *mesites*, caudally acute, equaling valves proper and touching bases of processes. Processes of anal valves at extreme superior angle (pl. 12, fig. 4).

Gonopods of male as shown in plate 12, figures 5 and 6.

Number of segments, 45.

Length, about 55 mm.; width, 5 mm.

Locality.—Guatemala: Cacao, one male (O. F. Cook. April, 1906).

Type.—Cat. No. 836, U.S.N.M.

69. OXYPYGE EQUALIS, new species.

Plate 12, figs. 7–10; plate 15, fig. 3.

Segments black dorsally excepting a narrow caudal border, on the sides and below black only in front of the suture, behind which they are fulvous. Anal valves dusky fulvous. Legs pale ferruginous. Head smooth and shining. Sulcus widely interrupted in the middle region. Eyes large and circular, the ocelli not convex and in part appearing poorly differentiated. Antennae as usual. The collum widely semicircularly rounded on each side below. A short marginal sulcus on each side. Second tergite extending below lower margin of collum, its ventral part forming a distinct, slightly obtuse angle with the lateral region. Anterior margin of ventral transverse portion bent down, as in other species of the genus. Striate below in the ordinary manner. Sulcus deep and complete across dorsum. Segmental sulcus on the following tergites also sharply marked and complete, a little curved forward about dorsocaudal edge of the contiguous pore, striate only beneath. Scobina very small; anterior impressions smaller than in *socia* and more convex, much more nearly semicircular. The anterior margin of segment between scobina is not convex, or less so that in *socia.* The anal tergite elongate and acutely produced, the tip of the cauda surpassing the valves proper and almost equaling the

processes of the latter. Anal smooth or but little roughened in caudal portion. The processes short, their apices acute and upturned (pl. 12, fig. 7).

Anal scale as shown in plate 12, figure 8.

Gonopods as represented in plate 12, figures 9 and 10.

Number of segments, 50.

Length, 4 mm.; width, 4 mm.

Locality.—Guatemala: Trece Aguas, 1 male (O. F. Cook, June 7, 1907).

Type.—Cat. No. 837, U.S.N.M.

Genus SPIROBOLUS Brandt.

70. SPIROBOLUS HOPLOMERUS Pocock.

Spirobolus hoplomerus Pocock, Biol. Centr.-Amer., Diplop., 1908, p. 76, pl. 7, fig. 5.

Locality.—Guatemala.

71. SPIROBOLUS STOLLI Pocock.

Spirobolus stolli Pocock, Biol. Centr.-Amer., Diplop., 1908, p. 77, pl. 7, figs. 3–3*e*, 4,

Locality.—Guatemala: Pachuta.

72. SPIROBOLUS EXIMIUS Porat.

Spirobolus eximius Porat, Ann. Soc. Ent., Belg., 1888, vol. 32, p. 248.

Locality.—Guatemala.

OXOBOLUS, new genus.

Body large and robust, typically about eight times longer than thick, narrowing a little forward and more strongly caudad. Clypeal foveolae 2+2 or 2+3. Collum acutely narrowed down each side, the angle narrowly rounded. Anterior border raised as far dorsad as level of lower edge of eye, opposite which the margin is sinuate. Repugnatorial pore above middle of side and lying in front of the principal sulcus or suture. No scobina present. Anal valves strongly compressed. Anal scale transverse, the caudal edge straight or nearly so.

In the male the seventh legs have the coxae much enlarged and these flattened anterocaudally, carrying the legs conspicuously farther ventrad than in the more anterior pairs; the coxae and the three following joints strongly compressed ventrally, their mesal edges forming a more strongly chitinous ridge. The sixth legs in male with similar chitinous ridges. Coxae of fourth and fifth legs strongly compressed anterocaudally and produced ventrad; the coxae of third legs similarly extended ventrad but scarcely compressed.

The posterior gonopods of the male characterized by having the coxae extended ectad at right angles to the telopodite; the tracheal stalk attached at its end along its dorsal edge and to the telopodite and extending ectodorsad from end of coxa. The telopodite is biramous, with the inner piece exceeding the outer piece in length and especially in stoutness, both divisions consisting of two joints fused but showing suture plainly. At base the telopodite is produced mesad and then distad in a process united by membrane with main body of telopodite. Ventral plate of anterior gonopods small, leaving coxae wholly uncovered, or nearly so, the middle part distadly pointed. Tracheal stalks stout, in line with axis of telopodite. Coxae completely fused with femuroid at middle, broadly in contact at middle line. Telopodite clearly biarticulate; the femuroid extended completely about posterior gonopod on its caudal side; the distal joint with a process from its distomesal corner; this process blunt, a little curved ectad.

Genotype.—Oxobolus virilis, new species.

Distinct from other genera in the structure of the posterior gonopods. In the unusual form of the anal sternite or scale like the West Indian *Thyroproctus;* but the latter genus has gonopods of the *Rhinocricus* type.

73. OXOBOLUS VIRILIS, new species.

Plate 12, figs. 11, 12; plate 13, figs. 1–3.

The body of the type is light olive brown on each segment in front of the pore and dark olive caudad of it. The legs are red, the antennae a darker red. The head is irregularly furrowed between antennae and below them, in the latter region also coarsely, irregularly punctate. The sulcus is complete and deeply impressed excepting for a short distance at level of antennae. Eyes comparatively small, circular, consisting of about 23 ocelli in five vertical series. Last joint of antennae with four sensory cones. Collum with anterior margin angled or convexly bowed forward just below level of eye. From this level to lower angle a margining sulcus is present, this leaving a rather broad border. In the type a longitudinal sulcus extends from eye level caudad to posterior border, where it meets a deep transverse sulcus extending dorsad but not crossing dorsum, this latter sulcus nearly obsolete in the paratype. Second tergite extending below level of collum and excavated or depressed at lower end for reception of the angle of the latter, its lower border extending much ventrad of the transverse ventral portion. The portion left uncovered below on each side shows two principal longitudinal sulci, an upper straight one and a lower curved one which bends up dorsad

at or under the edge of the collum. In the depression for end of collum are several vertical sulci, the ends of which extend out on the free surface below.

On the typical segments of the middle region the segmental suture is clearly detectable only ventrally and on lower part of sides, very vague or wholly absent dorsally, the vague trace of suture at level of pore angled. Segments striate only beneath, excepting the covered zone of prozonite, which is encircled by striolations; the striae of metazonite longitudinal, those on middle zone just in front of suture oblique. One or two deep transverse furrows setting off distal end of the anal tergite. Anal valves smooth, strongly compressed, much exceeding the tergite. Anal scale short and proportionately very broad, with the caudal edge straight and the anterior one convex (pl. 12, fig. 12).

Gonopods as represented in plate 13, figures 1, 2, and 3.

Seventh leg of male as shown in plate 12, figure 11.

Number of segments, male, 40.

Length, 97 mm.; width, 12.5 mm.

Locality.—Guatemala: Samoc, Coban (6,000 feet), two males (O. F. Cook, May, 1906).

Type.—Cat. No. 838, U.S.N.M.

74. OXOBOLUS CINCTUS, new species.

Plate 13, figs. 4–7.

A field note says that the segments in life are gray, of a slight yellowish cast, with a posterior band of black edged with light brown. In the preserved specimen there is a slight olive tinge to the light-colored part of the segments. Anal tergite black at tip, elsewhere pale. Anal valves of the light color. Legs and antennae ferruginous. Head smooth. Sulcus fine, interrupted at middle. Eyes less circular than in *virilis*, longer transversely. Ocelli about 21, in four transverse series. Sensory cones of antennae four in number. Collum and second tergite of form described for *virilis*. The second tergite has one or two sharply marked longitudinal sulci a little above level of lower end of collum.

Differing from *virilis* in that the segmental sulcus, though nowhere deep, is continuous as a fine line entirely across dorsum. The dorsum caudad of the suture marked with numerous, essentially longitudinal, impressed lines, which toward the suture are more numerous and anastamose more as they do caudad of the suture. Anal scale with caudal margin less straight, weakly obtusely angled behind at middle (pl. 13, fig. 4). Anterior legs of male modified, as in *virilis*. The chitinous ventral edges on sixth and seventh legs more elevated.

Gonopods as shown in plate 13, figures 5, 6, and 7.

Number of segments, male, 42.

Length, about 105 mm.; width, 13 mm.

Locality.—Guatemala: Trece Aguas, one male, June 6, 1907.

Type.—Cat. No. 839, U.S.N.M.

75. OXOBOLUS CRATUS, new species.

Plate 13, fig. 8.

Segments chestnut about middle, blackish anteriorly and in a narrow posterior band in front of the usual pale caudal edge. Legs and antennae chestnut. Eyes angled above. Ocelli about 24, in five transverse series. Sulcus on head interrupted in middle region. Head smooth above, but roughened on each side of face below antenna with punctae and vertical rugae. Differing from the two preceding species in having the clypeal foveloae 3+3. General form of first three tergites as in *cinctus.* Segments with principal sulcus fine, but complete across dorsum. Striate only below and on lower part of sides, the striae in front of sulcus oblique, those behind it longitudinal. The dorsal surface under lens shows numerous coriarious impressed fine lines and dots. Anal tergite transversely depressed, but not distinctly cross-furrowed. Anal sternite angled behind about as in *cinctus* (pl. 13, fig. 8).

Number of segments, female, 43.

Length, 140 mm.; width, 16 mm.

Locality.—Guatemala: "On road to Los Pinales," one female (G. P. Goll, April 29, 1907).

Type.—Cat. No. 840, U.S.N.M.

76. OXOBOLUS PICTUS, new species.

Plate 13, fig. 9.

A dark, olive-black band across each typical segment posteriorly, and a broader one anteriorly near and beneath edge of preceding segment. The posterior dark band bows forward in middle region to merge in characteristic way with the anterior dark band. The intermediate portion of segment and the posterior border chestnut. These bands all fade below into a lighter olive or dull-greenish color. The dark bands become more extensive on posterior segments. Collum with a broad olive band across its middle and a much narrower band along caudal edge and in middle part of anterior edge of same color; elsewhere chestnut. Head of dark-olive color above, chestnut below. Legs chestnut (noted as being pink in life). Eyes narrowing at mesal end. Ocelli 25 or 26, in five transverse (vertical) series. Sulcus interrupted as usual. Face roughened below, as in *cratus.*

Clypeal foveolæ 2×2. First three tergites in general form as in the other three species here described, the lateral and ventral portions of the second and third prominently angled, the two portions evenly rounding together on the fourth and following segments. The segmental suture absent or obscure above, though showing more traces than in *virilis*. The ridges liniting striae beneath not projecting in spinous points behind, as they do, for example, in *virilis* and *cratus*. The sides of the sternites anteriorly only weakly divergent. Caudal end of last tergite depressed, under lens seen to be more strongly and densely coriariously roughened than the anterior portion. Last sternites very obtusely angled behind (pl. 13, fig. 9).

Number of segments, female, 41.

Length, about 96 mm.; width, 12.5 mm.

Locality.—Guatemala: Coban. Samac coffee plantation, one female, May, 1904.

Type.—Cat. No. 841, U.S.N.M.

This species suggests *O. virilis*, the types of which come from the same locality. It differs in color and color pattern in not having the ventral ridges of segments spinous-pointed behind, in having the last tergite strongly coriariously roughened behind and transversely sulcate.

Genus SPIROBOLELLUS Pocock (an sen. str.?).

77. SPIROBOLELLUS ATRICULUS Pocock.

Spirobolellus articulus Pocock. Biol. Centr.-Amer.. Diplop., 1908, p. 88, pl. 7, figs. 9–9*c*.

Locality.—Guatemala: Volcan de Agua.

Genus ALLOPOCOCKIA Brölemann.

78. ALLOPOCOCKIA TYLOPUS (Pocock).

Spirobolellus tylopus Pocock, Biol. Centr.-Amer., Diplop., 1908, p. 87, pl. 7, figs. 8–8*d*.

Allopocockia tylopus Brölemann, Ann. Soc. Ent. France, 1914, p. 34.

Locality.—Guatemala: Tecpam.

AROLUS, new genus.

Collum triangularly narrowed down each side, the angle narrowly rounded below. Median plate of anterior gonopods (coleopods) of male reduced in size, slenderly triangular; coxæ broad, meeting over median plate and with mesodistal angles produced; telopodite deeply bifid, as in *Allopocockia*. Tracheal stalk from posterior gonopod very long, broad (see pl. 14, fig. 2). Anterior legs of male, particularly of third to seventh pairs, inclusive. strongly swollen beyond coxæ to second tarsal joint, which narrows conically distad. No special tubercle on first tarsal joint of any of the legs. Third to sixth legs

in male with ventrally directed processes from the coxæ. Two strongly chitinous, forward-curving processes from sternum of fourth segment. Anal valves smooth, weakly margined.

Genotype.—Arolus purulanus, new species.

Closely related to *Allopocockia.* From this readily distinguishable by the sternal processes of the fourth segment, the marked inflation of the third to the seventh legs between coxæ and second tarsal joint, and the absence of papilla from first tarsus of third legs, as well as by the characteristic structure of the gonopods.

79. **AROLUS PURULANUS**, new species.

Plate 13, figs. 10, 11; plate 14, figs. 1–7.

In general dark brown to nearly black, the caudal borders of segments paler, and the sides often lighter from the inclusion of groups of minute pale dots. Vertex of head, collum, and second tergite lighter in color, dusky fulvous to fulvous, under the lens showing a network of dark lines. Head dark between the eyes and antennæ down to a pale clypeal border, with a light included area just mesad of each eye and a small light spot on median line. In one specimen three segments in front of the last are also paler in color. Legs yellow. Sulcus across vertex and particularly deep over lower part of clypeus, absent in intermediate region. Face transversely wrinkled above lower sulcus and longitudinally furrowed on each side of it. Clypeal foveolæ 3+3. Antennæ short, the terminal joint with four sensory cones. Eyes subcircular, each composed of about 18 ocelli, in five series. Collum narrowed down each side, with the lower end rounded and a little inflexed, margined below and with a short longitudinal stria or sulcus above the margining one, or this obsolete (pl. 14, fig. 7). Second tergite not produced below, a little exceeded by the collum. Striate below. The ordinary segments are encircled by a very weak furrow or constriction marked with impressed circular or horseshoe-shaped impressions, with the pore lying well behind it. The area in front of it is also marked across dorsum with similar impressions, but beginning a little below level of the pore these are replaced with deep, curved striae. Anal tergite covering and slightly exceeding the valves, very obtusely angular behind. Mesal borders of valves but little elevated. Anal sternite transverse, the caudal margin obtusely angled (pl. 13, fig. 10). Legs of first two pairs in male only a little enlarged, but the third to seventh pairs are strongly inflated between coxae and second tarsal joint, the latter conically narrowing distad. Coxae of third, fourth, and fifth legs with prominent soft processes, which in place lie against the sternal processes. The coxae of sixth legs but little produced and those of seventh not at all (see pl. 14, figs. 3 to 6).

Gonopods as shown in plate 13, figure 11, and plate 14, figures 1 and 2.

Number of segments, male, 38.

Length, about 20 mm.; thickness, 2 mm.

Locality.—Guatemala: Purula, one male and an immature female. June, 1906.

Type.—Cat. No. 842, U.S.N.M.

Genus SPIROSTROPHUS Saussure and Zehntner.

80. SPIROSTROPUS MUSARUM (Cook).

Glosselus musarum Cook, Proc. U. S. Nat. Mus., vol. 40, 1911, p. 165.

Locality.—Costa Rica: La Colombiana.

Superfamily POLYDESMOIDEA.

Family STRONGYLOSOMIDAE.

Genus ORTHOMORPHA Bollman.

81. ORTHOMORPHA COARCTATA (Saussure).

Polydesmus coarctata Saussure, Mém. Myr. Mex., 1860, p. 39, fig. 18.
Orthomorpha coarctata Pocock, Ann. mus. civ. Genoa, 1895, ser. 2, vol. 14, p. 809.

Localities.—Costa Rica: Port Limon, several males and females (W. M. Wheeler); Guatemala: Puerto Barrios, male and females (W. M. Wheeler, January 15, 1921); Panama: Ancon, Canal Zone, many specimens (W. M. Wheeler, November, 1911).

Genus OXIDUS Cook.

82. OXIDUS GRACILIS (Koch).

Fontaria gracilis C. L. Koch, Syst. d. Myr., 1847, p. 142.
Orthomorpha gracilis Brölemann, Mém. Soc. Zool. France, 1905, p. 341.
Oxidus gracilis Cook, Proc. U. S. Nat. Mus., 1911, vol. 40, p. 628.

Localities.—Guatemala: San Lucas Toliman, several specimens (W. M. Wheeler, January, 1912); Costa Rica: San José.

Family PLATYRACHIDAE.

Genus TIRODESMUS Cook.

83. TIRODESMUS FIMBRIATUS (Peters).

Polydesmus (Stenonia) fimbriatus Peters, Mon. Ber. Akad. Wiss., Berlin, 1864, p. 543.
Platyrrhacus biolleyi Carl, Rev. Suisse Zool., 1902, vol. 10, p. 658, pl. 11, figs. 67, 68.—Brölemann, Ann. Soc. Ent. France, 1905, vol. 74, p. 341.
Tirodesmus fimbriatus Cook, Brandtia, 1896, vol. 12.

Localities.—Costa Rica: Three females and one male, collected by C. Bergdorf and P. Schild (Acc. 38,962, U.S.N.M.); Nicaragua: San Juan del Norte, a female, collected by J. F. Le Baron and compared with the type in Berlin Museum by O. F. Cook; also Machucha, one male, collected by Dr. J. E. Bransford.

Carl separates his species *biollyi* from *fimbriatus* because the type of the former does not show polygonal areas on the metazonites. These were also not evident on some of the specimens listed above when they were dry, but in all they became distinct when thoroughly clean or when in liquid. The gonopods are as figured by Carl for *biollyi*, and it is likely that this form is the same species as *fimbriatus*.

Genus NYSSODESMUS Cook.

Nyssodesmus Cook, Brandtia, vol. 12, 1896, p. 53.

The original diagnosis of this genus was based upon specimens in the Berlin Museum of a species as yet undescribed, though listed as the genotype under the name *N. alboalatus*. While it seems impossible to identify this Nicaraguan species from the facts included in the generic diagnosis, the latter applies clearly to the three new species here described and probably equally well to the others here listed. *Nyssodesmus* is used in preference to *Platyrachus* because of the indefiniteness of our present knowledge concerning the real characters of the latter in any restricted sense.

84. NYSSODESMUS NIGRICAUDUS, new species.

Plate 15, figs. 4–8.

In coloration very similar to *N. bivirgatus* (Carl), the keels and a broad dorsal band being yellow, while a narrower stripe along each side just within bases of keels is dark brown or blackish. The entire last tergite is black, as is also the caudal border of the preceding segment, whereas the caudal process in *bivirgatus* is yellow. The head is blackish and lacks the yellow patch on vertex that is present in *bivirgatus*. Legs and antennae dark brown. Vertex of head roughened, with a rounded elevation on each side of the median furrow, having at its summit a large, transversely elongate, smooth tubercle, prominent ridge along mesocaudal border of antennal socket. Collum broader than head, its anterior margin over middle region weakly convex; side lobes bluntly triangular, the anterior margin adjacent to angle with two or three tubercles or rounded teeth projecting forward and several obsolete ones mesad of these. Dorsal surface densely granulo-roughened, the anterior row of tubercles evident, but the posterior one obsolete in the type (see pl. 15, fig. 4). Keels broader than long. The pores are located far outside

the middle of the keel, the pore body lying less than once and a half from the margin between teeth, often scarcely more than its diameter (see pl. 15, fig. 5). Tubercles of sternites of normal form. The anal valves are strongly margined, the elevated rims being smooth. The setigerous tubercles are of moderate size, the anterior the larger, and are contiguous with but both distinct from the marginal rim. Margin of sides of last tergite scarcely elevated into a true tubercle to bear the upper lateral seta (see pl. 15, fig. 6). Tubercles of anal scale large, distally truncate (pl. 15, fig. 7). The gonopods when in place cross each other and fit into the depression on the sixth segment, as usual. The accessory branch is broad, but is narrower than the middle part of gonopod, distally rounded (pl. 15, fig. 8).

Length, 78 mm.; width, 13.5 mm.

Locality.—Costa Rica: One male (C. Bergdorf and P. Schild, Acc. 38,962, U.S.N.M.

Type.—Cat. No. 843, U.S.N.M.

85. NYSSODESMUS MIMUS, new species.

Plate 15, figures 9–11.

This species differs from the other two here described in having the dorsum between the keels uniform brown, the keels entirely yellow. Head brown, without a yellow area above. Last tergite brown at base above, with distal half of the caudal process yellow. Head less elevated each side of the vertigial furrow than in the preceding species and the antennal ridge less developed. Lateral margins of collum with six or seven low, nearly uniform, blunt crenations. Surface depressed transversely between anterior and posterior borders and across base of keel. Surface in general densely granular; a series of small tubercles across anterior border; the nongranular, somewhat elevated marginal thickening of the posterior border divided into tuberclelike segments by longitudinal furrows or depressions. The granulation of the surface of metazonites more pronounced and uniform than in *nicaraguanus.* The posterior border divided into areas by longitudinal sulci, as in the latter species. Anterior margin of keels oblique in about same degree as in that species; lateral margins weakly undulate, excepting notch at middle, which is deeper than in *nicaraguanus;* caudal processes of posterior region a little less acute. The pore body is a little nearer the margin at the median notch, mostly a little more than once and a half, but less than twice its diameter removed (pl. 15, fig. 9).

As in *nicaraguanus*, the caudal tubercle of the anal valves is fused with the marginal elevated rim, the larger anterior one remaining distinct. Anal scale with tubercles large, the caudal margin between them angled; lateral margin concave instead of a little convex (pl. 15, fig. 10).

The gonopods cross each other when in place. They resemble those of the preceding species. The accessory branch is more elongate than in *N. tristani* (Pocock), distally more narrowed, and the gonopod is narrower at level of origin of style, as shown in plate 15, figure 11.

Length, 70 mm.; width, 12.5 mm.

Locality.—Nicaragua: One male.

Type.—Cat. No. 5,020, M.C.Z.

86. NYSSODESMUS NICARAGUANUS, new species.

Plate 16, figures 1–4.

The type of this species is nearly the same as *nigricaudus* in coloration excepting that the caudal tergite is entirely yellow instead of black. The head much as in *nigricaudus;* the ridge mesad of the antennal socket larger. All metazonites have the posterior border crossed by longitudinal sulci, visible to the naked eye, which set off a transverse series of longitudinally oblong areas. The keels of the middle and posterior regions have their anterior margins obviously more oblique and the lateral margins less acutely dentate, the margins being typically simply undulate. The pore body is smaller and is farther removed from the margin, being mostly from two and a quarter to two and a half times its diameter from the nearest point of the margin (pl. 16, fig. 1). The anal valves have the anterior tubercle separated from the marginal rim but the posterior one is merged with the rim, so that its seta appears to be borne directly by the latter. The upper seta of lateral part of last tergite carried on a more distinct tubercular elevation. The tubercles of anal scale are more rounded than in *nigricaudus* (see pl. 16, fig. 2).

In the type of this species the gonopods do not cross each other, being less twisted than usual, but lie with their convexities in contact. Accessory branch proximally broad, with sides parallel, but distally acuminate as shown in plate 16, figures 3 and 4.

Length, male, 83 mm.; width, 13.5 mm.

Locality.—Nicaragua: Machucha, a male and female (Dr. J. E. Bransford).

Type.—In collection of Philadelphia Academy of Science.

87. NYSSODESMUS TRISTANI (Pocock).

Platyrachus tristani POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 141, pl. 10, figs. 6–6*b*.

Locality.—Costa Rica: La Palma.

88. NYSSODESMUS LIMONENSIS (Attems).

Platyrrhacus limonensis ATTEMS, Denks. Acad. Wiss. Wein, vol. 68, p. 344, pl. 14, fig. 319.

Locality.—Costa Rica: Port Limon.

89. NYSSODESMUS FRATERNUS (Carl).

Platyrrha us fraternus Carl, Rev. Suisse Zool., 1902, vol. 10, p. 655, pl. 11, fig. 71.

Localities.—Costa Rica: La Palma, Caché, Atlantic slope, San José, Port Limon.

90. NYSSODESMUS BIVIRGATUS (Carl).

?*Polydesmus* (*Odontodesmus*) *python* Peters, Mon. Ber. Berlin Akad., 1864, p. 543.
Platyrrhacus bivirgatus Carl, Rev. Suisse Zool., 1902, vol. 10, p. 652, pl. 11, fig. 65.
Platyrachus bivirgatus Pocock, Biol. Center.-Amer., Diplop., 1909, p. 142.

Localties.—Costa Rica: La Palma, San José, Carrillo.

91. NYSSODESMUS RIPARIUS (Carl).

Platyrrhacus riparius Carl, Rev. Suisse Zool., 1902, vol. 10, p. 642, pl. 12, fig 83.—Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 143.

Localities.—Costa Rica: Rio General, Pacific slope.

92. NYSSODESMUS MONTIVAGUS (Carl).

Platyrrhacus montivagus Carl, Rev. Suisse Zool., 1902, vol. 10, p. 662, pl. 12, figs. 84–88.—Brölemann, Ann. Soc. Ent. France, 1905, 74, p. 342.
Platyrachus montivagus Chamberlin, Trans. Amer. Ent. Soc., 1914, vol. 40, p. 189.

Localities.—Costa Rica: Carillo, La Palma, Volcan de Turrialba, Reventazon Valley.

93. NYSSODESMUS PROPINQUUS (Carl).

Platyrrhacus propinquus Carl, Rev. Suisse Zool., 1902, vol. 10, p. 665, pl. 12, figs. 80–82.

Localities.—Costa Rica: Las Delicias, Santa Clara.

94. NYSSODESMUS STENOPTERUS (Brölemann).

Platyrrhacus stenopterus Brölemann, Ann. Soc. Ent. France, 1905, p. 343.
Platyrachus stenopterus Pocock, Biol. Centr.-Amer. Diplop., 1909, p. 145, pl. 10, figs. 8–8c.

Locality.—Costa Rica: Rancho Redondo.

95. NYSSODESMUS ANTIUS (Chamberlin).

Platyrachus antius Chamberlin, Trans. Amer. Ent. Soc., 1914, vol. 40, p. 189, pl. 2, figs. 4, 5.

Locality.—Costa Rica: Juan Viñas, Reventazon Road.

96. NYSSODESMUS POCOCKI (Brölemann).

Platyrrhacus pococki Brölemann, Bull. Soc. Ent. France, 1911, p. 14.

Locality.—Costa Rica: Cuesta del Tablazo.

Family EURYURIDAE.

Genus AMPLINUS Attems.

97. AMPLINUS AREATUS Pocock.

Amplinus areatus Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 151, pl. 11, figs. 4–4*f*.

Localities.—Guatemala: La Tortuga, Petalhuleu, Livingston, two males collected by H. Wilson in 1885.

98. AMPLINUS NITIDUS (Brölemann).

Platyrrhacus nitidus Brölemann, Mém. Soc. Zool. France, 1900, vol. 13, p. 97, pl. 6, figs. 18–20.
Pachyurus nitidus Carl. Rev. Suisse Zool., 1902, vol. 10, p. 638.
Amplinus nitidus Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 149, pl. 11, fig. 3.

Locality.—Guatemala.

99. AMPLINUS PALICAUDATUS (Attems).

Pachyurus palicaudatus Attems, Mitt. Mus. Hamb., 1901, vol. 18, p. 98, pl. 50, fig. 8.—Carl, Rev. Suisse Zool., 1902, vol 10, p. 638.
Amplinus palicaudatus Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 150, pl. 11, figs. 1–1*e*.

Localities.—Guatemala: Quetzaltenango, Cholhuitz.

100. AMPLINUS CONVEXUS (Carl).

Pachyurus convexus Carl, Rev. Suisse Zool, 1902, vol. 10, p. 633, pl. 11, fig. 57.
Amplinus convexus Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 150.

Locality.—Costa Rica.

101. AMPLINUS FLAVICORNIS Pocock.

Amplinus flavicornis Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 151, pl. 11, figs. 2–2*f*.

Locality.—Central America.

102. AMPLINUS MANNI, new species.

Plate 16, figs. 5–7.

Prozonites, so far as normally exposed, black to dark chestnut. The metazonites light brownish yellow to brown, the anterior border darker, the darker color extending out along anterior edge of keels also. Outer part of keels bright yellow. Last tergite distally yellow, proximally becoming dark chestnut or blackish. Legs yellow of a dilute brownish tinge. The antennae similar excepting the sixth article, which is blackish. Collum with four rows of polygonal areas, which are indistinct in middle region; areas smaller on base of keel and more or less merged on outer part. Keels of following tergites with

anterior corners rounded; margin smooth, wholly without teeth or serration. The lateral margin of second and third keels doubly sinuous, the median portion bowing out a little convexly. Posterior angles of second and third keels only weakly produced, those of the following keels more distinctly produced, more and more so in going caudad. Margins of keels strongly thickened. Dorsal surface of metazonites in general with three transverse rows of polygonal areas, these well developed entirely across dorsum excepting on second and third plates where they are weaker in the middle region. The areas more elevated on the keels as usual. On the nineteenth tergite the polygonal areas of the caudal row are strongly marked entirely across the width, those of the middle row weaker, while those of the anterior row are obsolete in the middorsal region. Sides of metazonites granular, the under surface of the keels smooth.

Anal scale as shown in plate 16, figure 5.

Gonopods of the male with inner distal branch much more slender than the outer and conspicuously curved. Outer branch flattened, blade-like, distal end obliquely truncate, with acute point at one angle. See further plate 16, figures 6 and 7.

Length, 50 to 60 mm.; width 8 mm. in female, 7 mm. in male.

Locality.—Honduras: La Ceiba (type locality), four specimens; Lombardia, one specimen (W. M. Mann).

Type.—Cat. No. 844, U.S.N.M.

103. AMPLINUS ORPHNIUS, new species.

Plate 16, fig. 8.

Dorsum black, with the two posterior rows of areas on each metazonite a little lighter; black of a somewhat chestnut tinge. Keels yellow excepting at base. Last tergite black across base, elsewhere yellow. Legs and antenna brown. The collum with the usual four transverse series of polygonal areas, of which the anterior and posterior series continue across dorsum, while the areas of the two intervening series are there obliterated. On the other metazonites there are three transverse rows of stringly differentiated polygonal areas, these being more elevated and pronounced than in the preceding species. On the ninteenth tergite the areas of the anterior series are obliterated, while those of the two posterior ones are conspicuously developed, those of the more anterior of these rows being shorter and more tubercle-like. Marginal thickening of keels in general less pronounced than in manni. In the gonopods the outer branch is relatively more slender and less blade-like than in manni and is distally gradually and acutely acuminate. Both branches curve ventrad at distal end (see pl. 16, fig. 8).

Length, 44 to 60 mm.; width of male 7.2 mm., of female, 9 mm.

Localities.—Honduras: La Ceiba (type locality), a male and female (W. M. Mann); Guatemala: Livingston, one male (W. Wilson, February, 1885).

Type.—Cat. No. 845, U.S.N.M.

The male from Guatemala is larger than the type and has the margins of the posterior keels a little more oblique. The tip of the outer processes of the gonopods appear to have been broken off (Cat. No. 5021, M.C.Z.).

104. AMPLINUS NITEUS, new species.

Plate 16, fig. 9.

This is a large form readily distinguishable in having the polygonal areas obsolete in the middle region of all the tergites, the median region to the naked eye appearing smooth and shining. Under the lens, however, the areas are seen to be vaguely outlined and become normally developed in the lateral regions where they form the usual three series, these extending out to the marginal thickening of the keels. The nineteenth tergite is entirely smooth, no polygonal areas at all being developed. The posterior angles of keels from the fourth caudad are a little produced and even in the most posterior the processes are of but moderate length. The anal valves present a smooth, low, rounded swelling over middle region, this leaving a longitudinal furrow at ectal border and one along mesal marginal thickening. Anal scale of usual form.

Gonopods as shown in plate 16, figure 9.

The type has apparently become bleached from long preservation, so that the original coloration can not be given.

Length, male, about 65 mm.; width, 10 mm.

Locality.—Costa Rica: Basin of San Juan River (P. Biolley).

Type.—Cat. No. 846, U.S.N.M.

Genus POLYLEPISCUS Pocock.

105. POLYLEPISCUS STOLLI Pocock.

Polylepiscus stolli Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 155, pl. 12, figs, 3–3*d*.

Locality.—Guatemala: Cholhuitz.

106. POLYTEPISCUS ACTAEON Pocock.

Polylepiscus actaeon Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 155, pl. 12, figs. 2–2*c*.

Locality.—Guatemala.

107. POLYLEPISCUS FURCIFER Pocock.

Polylepiscus furcifer Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 156, pl. 12, figs. 1–1*h*.

Locality.—(?) Guatemala.

108. POLYLEPISCUS HETEROSCULPTUS (Carl).

Pachyurus heterosculptus Carl, Rev. Suisse Zool., 1902, vol. 10, p. 635, pl. 12, figs. 73–75.

Polylepiscus heterosculptus Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 157,

Locality.—Guatemala.

Genus APHELIDESMUS Brölemann.

109. APHELIDESMUS CALVERTI Chamberlin.

Aphelidesmus calverti Chamberlin, Trans. Amer. Ent. Soc., 1914, vol. 40, p. 191, pl. 2, figs. 6, 7.

Localities.—Costa Rica: La Emilia; Port Limon. Two males and a female taken at the latter locality in November, 1911, by W. M. Wheeler.

110. APHELIDESMUS INTERMEDIUS Chamberlin.

Aphelidesmus intermedius Chamberlin, Trans. Amer. Ent. Soc., 1914, vol. 40, p. 192, pl. 2, figs. 8–10.

Locality.—Costa Rica: Juan Vinas.

111. APHELIDESMUS GLAPHYROS (Attems).

Euryurus glaphyros Attems, Denks. Akad. Wiss. Wien, 1900, vol. 68, p. 279, pl. 7, figs. 163, 164.

Aphelidesmus glaphyros Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 158.

Localities.—Costa Rica: Carrillo; Cuesta de Tablazo.

Family LEPTODESMIDAE.

Genus CHONDRODESMUS Silvestri.

112. CHONDRODESMUS SINGULARIS, new species.

Plate 16, figs. 10–13.

Light chestnut above, with outer part of keels yellow. The sides and venter pale. The collum with anterior and lateral margins together forming an evenly convex curve; the caudal margin arcuate, the lateral portions bending forward. In the second tergite the an-

terior corner of the keel is rounded, the posterior one more narrowly so, a little obtuse. In the third and fourth keels the posterior angle is more obtuse. On the keels from the second to the fourth there is a slight lateral tooth at the anterior corner. The keels of the middle and posterior regions of the body in particular are very narrow. In the nonpore-bearing keels both corners are rounded and the margins are bent up uniformly all around excepting a slight raised angle or tubercle at the caudal corner; both anterior and posterior margins convex. The porigerous keels are similar with the addition of the sharply set-off, protruding, pore-bearing process, which is in cross section a little elliptic and projects laterad from the margin. Anteriorly the pore body is near the middle of the side, but shifts farther and farther back in going caudad and is at the caudal corner on the seventeenth segment, though projecting only slightly caudad. Only on the eighteenth and nineteenth keels are the posterior angles produced, but the processes are slight. In these most posterior keels the pore swelling is less sharply set off and does not project out laterad (see further pl. 16, figs. 10, 11, and 12).

Anal scale as shown in plate 16, figure 13.

Length, about 32 mm.; width, 4.5 mm.

Locality.—Costa Rica: Port Limon, one female (W. M. Wheeler, November, 1911).

Type.—Cat. No. 5022, M.C.Z.

While only the female of this species was secured, the form of the keels is so characteristic that there will probably be no difficulty in its recognition.

113. CHONDRODESMUS TUBERCULIFER, new species.

Plate 17, figs. 1–6.

Chocolate brown above, the prozonites sometimes black, with outer portion of keels yellow. Legs and antennae fulvous, the former sometimes in part tinged with brown. Anterior and lateral margins of collum forming an even and broadly convex curve. Caudal margin arcuate, a little concave toward each end, so that the caudolateral angles are a little acute, not at all rounded. First, second, and third keels as broad as the fourth and fifth. Anterior corners of the keels rounded, and on the first ones with a small tooth at the lateral edge. Caudal corners of second to fourth keels rectangular (pl. 17, fig. 1). On the porigerous keels the caudal corner appears to be angularly excised behind the pore swelling, the outer edge of the posterior expansion beginning at caudal edge of swelling (pl. 17, fig. 2). On the fifteenth keels the angle of posterior margin extends caudad the same distance as the outer process, but on the sixteenth the latter

obviously exceeds it (pl. 17, fig. 3). On the segments of the middle region of the body the pore swelling is obviously behind the middle of length of keel, as shown in the figures. Dorsal surface of metazonites densely granular, with two transverse series of distinct, larger tubercles behind the middle. Sternites broad, without processes excepting a low, pointed tubercle at base of each posterior leg and a less distinct one at base of anterior leg on posterior segments. On the last two sternites these processes are more developed.

Anal scale broad, mesally extended into an acute process between the two setae (pl. 17, fig. 4).

Proportions of points of legs as represented in plate 17, figure 6.

The gonopods of the male are characterized by having the accessory blade broad and abruptly narrowed below the distal end, thus appearing shouldered on the mesal side, with the apical portion shaped something like a bird's head in outline (see further pl. 17, fig. 5).

Length, about 52 mm.; width, 7.2 mm.

Locality.—Honduras: La Ceiba, two males (W. M. Mann).

Type.—Cat. No. 847, U.S.N.M.

114. CHONDRODESMUS ALIDENS, new species.

Plate 17, figs. 7–9.

Chocolate brown, with outer part of keels and a narrow band across caudal border of metazonites yellow. Legs and antennae fulvous. The keels are narrower and a little more depressed than in the preceding species and differ conspicuously in form. The angular extensions of the caudal margin of keels is more pronounced. On the pore-bearing segments of the middle region of the body the pore swelling is obviously farther forward, being near the middle of the length of keel, as shown in plate 17, figure 7. The posterior corners of fifteenth keels is still excavated instead of being carried into a process caudad of posterior margin. The production is also much less developed on the sixteenth keels, where the angulation of the caudal margin extends as far caudad as the caudal process proper (pl. 17, fig. 8). The dorsal surface is densely finely granular, but quite lacks the series of tubercles as shown in the preceding species.

The anal scale is proportionately broader, with the caudal angle more abruptly produced (pl. 17, fig. 9).

Width, 7 mm.

Locality.—Honduras: La Ceiba, two females W. M. Mann).

Type.—Cat. No. 857, U.S.N.M.

115. CHONDRODESMUS PANAMENUS, new species.

Plate 17, fig. 10; plate 18, figs. 1–3.

Chestnut in color, with the keels and a narrow, interrupted median longitudinal stripe along the prozonites and on the anterior part of

metazonites yellow. Cauda yellow distally and along middle. Head smooth. The sulcus across vertex sharply impressed. Anterior margin of collum less convex at sides than in the middle. Anterior corner rounded as usual, the posterior one nearly rectangular. Caudal margin convex each side of the weakly and widely concave median portion, the lateral portions straight. Dorsal surface transversely depressed behind the middle part of anterior border, this border thus appearing elevated. Second, third, and fourth keels with posterior angles subrectangular, the anterior ones rounded, smooth, with no lateral tooth. None of the keels have the posterior angles more than slightly produced until those of the seventeenth segment. Those of eighteenth a little more acute. Those of nineteenth small, with keel in front of pore swelling essentially obliterated (pl. 18, figs. 1 and 2). Caudal margin of keels normally with two teeth, but sometimes with only one. The lateral margin of the pore-bearing keels indented in front of the pore swelling excepting on seventeenth, eighteenth, and nineteenth segments. The surface of all the metazonites, including the collum, is strongly roughened, with numerous small and irregularly polygonal, weakly elevated areas. The areas are larger in two caudal transverse rows on the last segments, a caudal series of areas less distinctly indicated on others.

Last tergite and anal scale as shown in plate 17, figure 10. and plate 18, figure 3.

Length, about 58 mm.; width, 9 mm.

Locality.—Panama: One female.

Type.—Cat. No. 5023, M.C.Z.

Also a number of dried and broken specimens labeled "Panama. Dauro" represent this species.

116. CHONDRODESMUS MONTANUS (Pocock).

Dirhabdophallus montanus POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 163, pl. 12, figs. 4–4*g*; pl. 13, fig. 2.

Locality.—Guatemala: Volcan de Agua.

117. CHONDRODESMUS GRANOSUS (Carl).

Leptodesmus plataleus granosus CARL, Rev. Suisse Zool., 1902, vol. 10, p. 602, pl. 10, fig. 27.

Dirhabdophallus granosus POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 164, pl. 12; figs. 5–5*b*.

Localities.—Costa Rica: La Uruca; San José.

118. CHONDRODESMUS RODRIGUEZI (Brölemann).

Leptodesmus rodriguezi BRÖLEMANN, Mém. Soc. Zool. France, 1900, vol. 13, p. 103, pl. 6, figs. 43–46.

Dirhabdophallus rodriguezi POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 164.

Locality.—Guatemala: Purula.

119. (?) CHONDRODESMUS HOFFMANNI (Peters).

Rhacophorus hoffmanni PETERS, Mon. Ber. Akad. Wiss. Berlin, 1864, p. 537.
Dirhabdophallus hoffmanni POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 165.

Locality.—Costa Rica.

Genus CYCLORHABDUS Brölemann.

120. CYCLORHABDUS CONTORTUS Brölemann.

Cyclorhabdus contortus BRÖLEMANN, Mém. Soc. Zool. France, 1900, vol. 13, p. 98, pl. 6, figs. 21–25.

Locality.—Guatemala.

Genus PHYLACTOPHALLUS Pocock.

121. PHYLACTOPHALLUS STENOMERUS Pocock.

Phylactophallus stenomerus POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 166, pl. 12, figs. 3–3*h*.

Locality.—Costa Rica: Irazu.

Genus EUTYPORACHIS Pocock.

122. EUTYPORACHIS TESSELLATUS Pocock.

Eutyporachis tessellatus POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 169, pl. 13, figs. 4–4*c*.

Locality.—Guatemala: Senahu in Alta Vera Paz.

123. EUTYPORACHIS OLTRAMAREI (Carl).

Leptodesmus oltramarei CARL, Rev. Suisse Zool., 1909, vol. 10, p. 600, pl. 10, fig. 34.
Eutyporachis oltramarei POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 170.

Locality.—Guatemala.

Genus ALOCODESMUS Silvestri.

124. ALOCODESMUS DROMEUS, new species.

Plate 18, figs. 4–7.

As the type specimen of this species had gone dry, the original coloration is largely lost. It appears to have been brown, with the keels, or at least their processes, yellow. Legs fulvous. Antennae brown. Collum with posterior angles acute and a little produced caudad. Dorsal surface densely finely granular, smoother anteriorly, with some larger smooth tubercles along caudal border and behind middle. Setae normal (pl. 18, fig. 4). From the fourth or fifth segment caudad the metazonites crossed by a distinct transverse furrow, in front of which are two setae. The surface densely granular, with two transverse series of larger tubercles behind the sulcus, the numerous granules crowded between the tubercles. The prozonites more

finely granular or shagreened. All keels from second segment caudad, with posterior angles conspicuously acutely produced, those of the posterior region becoming smaller than those of middle region. Spines of sterna short but distinct, those of last segment not especially enlarged.

Anal scale as shown in plate 18, figure 5.

Legs, long.

The gonopods of the male resemble those of *A. angustatus* Silvestri; but the lesser blades of the femoral process are unequal and curve distally in the direction opposite to the curve of the principal blade. The main lamina of the principal branch is more finely and regularly toothed, etc. (see pl. 18, figs. 6 and 7).

Locality.—Panama: Canal Zone, Culebra (type locality), numerous specimens "taken under bushes in garden" (A. H. Jennings, April 30, 1909); also one male in the Museum of Comparative Zoology collection, taken at Irenao, in the Canal Zone.

Type.—Cat. No. 848, U.S.N.M.

ATYLOPHOR, new genus.

Body composed of head and 20 segments. Head densely clothed in front, with mostly short setae, bearing finer and longer setae above. Vertigial sulcus well developed. Antennae moderately long and slender, increasing a little in thickness distad to end of sixth article. Sixth article typically a little longer than the fifth. Collum semicircular in outline, the lateral and anterior margins forming an even arc; as wide as second tergite; dorsal surface with series of setae. Keels high, the second at the same elevation as the others. Anterior keels well developed, those caudad of the fifth more weakly so, only a little projecting over the sides and with anterior portions largely appearing as a simple swelling of the segment as in many craspedosomids. Keels strongly margined, the lateral border more thickened, especially about the pores. Posterior angles produced on all or nearly all segments, though the processes are all typically short. Metazonites with a well-marked transverse sulcus. Typically with surface bearing low setiferous tubercles. Pleural keels present. Ventral plates much wider than long, without either longitudinal or transverse furrows and without processes in the male. Last tergite conical, with tip truncate. Anal scale subtriangular. Legs slender, the anterior pairs not thickened or otherwise modified in the male and bearing no tarsal pads. Last joint long, typically as long as the two preceding joints taken together. Coxa of gonopods with a hook. Telopodite deeply divided, having a dorsal (caudal), distally laminate and more or less lobed division and a slender, distally acuminate, tibial branch which exceeds the other in length and is typically in part supported by the latter.

Genotype.—*Atylophor rafaelanus*, new species.

This genus is related to *Trichomorpha*, a genus represented by numerous species in Colombia and Ecuador. It differs from this genus in having the anterior legs of the male without tarsal pads and otherwise without special modification. The tarsus has a greater proportionate length in all the legs. The keels are more weakly developed, as are also in particular the processes of their posterior angles. It also suggests the Guatemalan *Eutyporachis*, but differs in the form of the gonopods and in the smaller proportionate length of the sixth article of the legs.

125. ATYLOPHOR RAFAELANUS, new species.

Plate 18, figs. 8–11; plate 19, figs. 1–3.

Brown, with keel borders fulvous, area narrow in correspondence with reduction of keels. Dorsum arched. Keels high, narrow, especially in median and posterior regions, where consisting of simple bulgings of the segments, which are, however, deeply margined anteriorly and laterally. The pore-bearing region of keels strongly thickened and distinctly set off from the anterior portion of border, the thickening elliptic in outline as seen from the side, Margin setigerous. The slight caudal margin of keels not dentate. Tooth at anterior corner obsolete (see pl. 18, figs. 10, 11). Metazonites with a transverse sulcus, behind which there are typically two rows of tubercles or elevated areas, of which those of the posterior row are the larger, these areas setigerous. In front of the sulcus the surface is nearly smooth, being rather obscurely set off into six larger areas, each of which bears a seta, the setae forming a single transverse series. Caudal end of body represented in plate 18, figure 8. Sides of body granular, more strongly so in anterior region. Pleural keels present back to the eighth segment. Ventral plates about twice as wide as long in the female, narrower in the male. All wholly lacking furrows and special processes in the male. Legs slender, with tarsus proportionately long and the two preceding joints short, as shown in plate 18, figures 10 and 11. Last ventral plate broadly subtriangular, with the sides convex, a little notched on each side opposite base of seta (pl. 18, fig. 9). Anal valves with mesal borders very strongly elevated; surface longitudinally rugose.

Gonopods of male as represented in plate 19, figures 1–3.

Length, male, about 21 mm.; width, 2 mm. Length of a female, about 25 mm.; width, 2.5 mm.

Locality.—Guatemala: San Rafael, one male and two females (O. F. Cook, June 4, 1914).

Type.—Cat. No. 849, U.S.N.M.

SCHISTIDES, new genus.

Composed of head and twenty segments. Head with a distinct sulcus across vertex. Antennae long, not much increasing in thickness distad; the second to sixth articles long, not much differing in length. Collum semicircular, the anterior margin more straight in middle region than laterally; anterior corners of keels rounded, the caudal corners acute; nearly as wide as second tergite; setiferous. Keels of the following tergites produced caudad, as in *Trichomorpha*. Also the tergites are similarly impressed with deep transverse sulcus, behind which are typically two series of tubercles. Sternites in male without processes. Anal tergite triangular, truncate at tip. Anal scale somewhat triangular, acute, behind, the sides convex. Legs slender. None of them modified in the male. No tarsal pads.

In the gonopods of male the coxa is thick and cylindrical. In the telopodite the femur is distinctly separated, narrow, the mesal side with a pit lined with hairs. Tibia deeply divided into two branches of which the dorsal (caudal) is broader and more plate-like and curves about the other distally; the ventral or anterior division expanded into more lamellar form distally and giving rise at distal end to a slender style which in the genotype is geniculate.

Genotype.—Schistides atopophallus, new species.

In general structure nearest *Trichomorpha*, but differing especial in the characters of the gonopods, such as in the distinct segmentation of the telopodite, the narrow femur, the deeper division of the tibia, the different seminiferous process, etc. Also differing in lacking any secondary modifications of the legs and sternites of the male.

126. SCHISTIDES ATOPOPHALLUS, new species.

Plate 19, figs. 4–9.

Dorsum chocolate brown or almost black, the caudal angles of the keels yellow. Antennae chocolate brown. Legs brownish yellow. Dorsum weakly arched. Keels high, a little bent upward. Posterior angles of keels strongly produced, the processes becoming longer in the posterior region, the ends not at all curved. Anterior angles of keels rounded. On second, third, and fourth keels the outer margin presents a small anterior tooth followed by two larger teeth or crenations. On the pore-bearing keels there is but one distinct marginal tooth, this large and immediately in front of porigerous thickening. In the nonpore-bearing keels caudad of the fourth there are mostly only two serrations or crenations, the third being obsolete (pl. 19, fig. 5). Dorsal surface of prozonites wholly smooth. Metazonites with a deep transverse sulcus, behind which there are two rows of

tubercules, typically six or five in an anterior row and seven to nine more elongate ones in the posterior row. In front of the sulcus the surface is smooth excepting for two small and well-separated tubercles on each side at the anterior border. Some tubercles at least are setigerous, but most setae are lost in the type. Basal portion of keel somewhat convexly swollen and bearing usually two or three tubercles. None of the sternites in the male have processes and none of the legs present secondary modifications. No metatarsal pads. Processes of the second coxae in the male short, erect.

Gonopods of the male as shown in plate 19, figures 8 and 9.

Length, about 21 mm.; width, 2.5 mm.

Locality.—Honduras: San Juan Pueblo, one male (W. M. Mann).

Type.—Cat. No. 850, U.S.N.M.

TUNODESMUS, new genus.

Body composed of head and twenty segments. Antennae long and slender. Collum much broader than the head and only slightly narrower than second tergite, the lateral ends acutely angular. Dorsum convexly arched. Metazonites without distinct transverse sulcus, and wholly smooth. Keels high, large, wider than long, a little depressed; posterior angles of keels acute, the angles becoming more and more produced caudad in going from anterior to posterior end of body; anterior and posterior margins of keels wholly smooth, as is also the lateral margin, excepting for the small anterior tooth; margins of keels not thickened. Pores on segments 5, 7, 9, 10, 12, 13, and 15–19; on posterior portion of keel opening above a little mesad of margin. Last tergite triangularly narrowed caudad, apically truncate. Ventral plates broader than long. At base of each posterior leg a conical process which is directed caudad and is more elongate in posterior region and less developed or absent in the anterior. Less developed tubercles may also occur at bases of anterior legs of segment. Legs not granular or spined and without special lobes or other modifications in the male, excepting that the second tarsal joints bear pads beneath. Coxal processes of second legs in the male directed caudad, slender.

In the gonopods of the male the coxae are long, thick, and erect and typically not much out of line with the telopodite. Coxal hooks present. Telopodite with two principal distal branches, an ectal one which is broad and laminate and may be lobed and which protects a slender branch on its mesal side. On caudal side, lower down, the telopodite angularly produced in a conical or laminate process of varying length.

Genotype.—*Tunodesmus orthogonus*, new species.

127. TUNODESMUS ORTHOGONUS, new species.

Plate 19, fig. 10; plate 20, figs. 1–9; plate 21, figs. 1, 2.

Dorsum brownish, most metatergites fuscous caudally and across keels mesad of the caudolateral corners and processes, which are pale ferruginous. A series of narrow light spots form a median longitudinal line on dorsum. Venter and legs paler, brownish yellow. Head dark over vertex and frons, elsewhere pale. Antennae fuscous, the last joint pale. Head with a fine sulcus across vertex and two principal setae each side of it. Collum convexly arched, the keels continuing nearly the same arc as the dorsum and descending down on each side of the head, which they greatly exceed. Anterior margin straight across middle region, laterally curving back around anterior corners of keels. Posterior margin arcuate, being concave at middle and convex each side of middle (pl. 20, figs. 1, 2). Surface of all segments wholly smooth. Caudal angles of keels of second and third segments subrectangular. Posterior angles of other keels acute, becoming more and more produced in going caudad. Anterior margins of keels bowed convexly; anterior corners rounded; a single small serration on lateral margin; posterior margin also convex at base, wholly smooth (pl. 20, figs. 3, 4). Sternal processes or tubercles present both at base of anterior and of posterior legs, the latter the larger. These tubercles present forward to fifth or sixth segment, but of reduced size in the anterior region. Tubercles densely pilose. Posterior tubercles of last two or three segments more elongate and slender (pl. 20, fig. 5).

Anal scale somewhat triangular, but caudally rounded and notched on each side near level of seta, the sides also convex (pl. 19, fig. 10).

A leg of male is shown in outline in plate 20, figure 7.

Gonopods represented in plate 20, figure 9, and plate 21, figures 1,2.

Length, male, 21 mm.; width, 4.8 mm.

Locality.—Guatemala: San Rafael, one male (O. F. Cook, June 4, 1914).

Type.—Cat. No. 851, U.S.N.M.

128. TUNODESMUS LAMINIGER, new species.

Plate 21, figs. 3–5.

Coloration in general as in the preceding species, but the light area of keels not extending so far forward, typically restricted to the caudal process. The keels are similar to those of *orthogonus*, but the anterior margin curves more strongly forward, while the posterior margin is proximally more strongly convex (pl. 21, fig. 3).

The species is most readily distinguishable by the structure of the gonopods of the male. The anteriorily directed end of the distal

lamina is emarginate, and presents thus two teeth or angles, the corresponding margin in *orthogonus* being entire. A pronounced difference is in the caudal process at base of tibial division, this being very much smaller in the present species and having ectad of it a low, but broad laminate process (pl. 21, figs. 4 and 5).

This species is a smaller form than the preceding, the male type being 18 mm. long and 4 mm. wide.

Locality.—Guatemala : San Rafael, one male and one female (O. F. Cook, June 4, 1914).

Type.—Cat. No. 852, U.S.N.M.

SYNTHODESMUS, new genus.

A genus closely related to *Tunodesmus*, as above described, excepting in the structure of the gonopods, which differ conspicuously. In these the telopodite, which is bent forward at right angles to the coxa, is proximally stout, but in the tibial region is abruptly slender. It is straight and terminates in two short and slender processes, of which the mesal one conducts the seminal canal.

Genotype.—*Synthodesmus simulans*, new species.

129. SYNTHODESMUS SIMULANS, new species.

Plate 21, figs. 6–9; plate 22, figs. 1, 2.

Dorsum brown excepting a pale median dorsal line of narrow marks, which may be connected in the posterior region. Under the lens small light dots, separated by a network of dark lines, show on each side, particularly in an area at and above base of keel. Venter and legs fulvous. The first two and the last two articles of antennae commonly pale, the intervening ones fuscous. Anterior and lateral margins of collum together forming an even arc, with the median region somewhat flattened. Caudal margin only slightly arcuate, being nearly straight (pl. 21, fig. 6). General form of other keels as in *Tunodesmus orthogonus.* Posterior angles of fourth keels nearly rectangular. Posterior angles of fifth and succeeding keels acute and produced more and more strongly in going caudad. Margins of keels a little bent up, but not thickened. Pores caudad of middle, opening well mesad of the margin (pl. 21, fig. 7). Sternites with processes near bases of posterior pair of legs on segments of middle and posterior regions of body, those of posterior segments best developed, conical, shorter than in the species of *Tunodesmus* previously described (pl. 22, fig. 1).

Anal scale pentagonal, the caudal end being obtusely angular, as shown in plate 21, figure 8.

An anterior leg of male is represented in plate 21, figure 9.

Gonopods as represented in plate 22, figure 2.

Length, male type, about 17 mm.; width, 3.4 mm.

Locality.—Guatemala: San Rafael, five specimens (O. F. Cook, June 4, 1914).

Type.—Cat. No. 853, U.S.N.M.

Family XYSTODESMIDAE.

Genus RHYSODESMUS Cook.

130. RHYSODESMUS CHAMPIONI Pocock.

Rhysodesmus championi POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 198.

Locality.—Guatemala: Zapote, Pacific slope.

131. RHYSODESMUS STOLLI Pocock.

Rhysodesmus stolli POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 198, pl. 15, figs. 3–3*b*.

Locality.—Guatemala: Retalhuleu.

132. RHYSODESMUS VIOLACEUS (Brölemann).

Fontaria violaceus BRÖLEMANN, Mém. Soc. Zool. France, 1900, vol. 13, p. 101, pl. 6, figs. 33–36.

Locality.—Guatemala.

amily RHACODESMI DAE.

CURODESMUS, new genus.

Related to the Mexican genus *Neoleptodesmus* of Carl, with which it agrees in the general form and structure of the body, but from which it differs in the structure of the gonopods. In these the telopodite is similarly trilobed distally; but the laminate lobe bearing the seminal channel is short and is on the inner side, the other two being ectad of it, the median one the smaller, the ectal one rounded. Telopodite rather short, distally bent into a half cylinder, with open side caudoectad (ventroectad); seminal fossa at base on mesal side large, extending openly distad, densely lined with setae.

Genotype.—*Curodesmus guatemalensis*, new species.

133. CURODESMUS GUATEMALENSIS, new species.

Plate 22, figs. 3–6; plate 23, figs. 1–4.

Brown or greyish brown, the outer portions of keels fulvous. Venter, legs, and antennae fulvous or yellow. In addition to the two longer setae each side of the vertigial sulcus above, the head bears numerous setae, especially over the frontal and clypeal regions. Antennae long, not enlarged distad (pl. 23, fig. 1). The collum

much exceeding the head in width and as wide as the second tergite. As long at base of keels as at middle. Anterior margin weakly convex, with anterolateral corners of keels rounded evenly and caudal corners subrectangular or slightly acute. Caudal margin concave at middle, convex each side of this, and then straight or a little concave at each end (pl. 22, fig. 3). Keels in general high on body, horizontal or a little raised. Keels of second, third, and fourth segments longer than median region of metatergites. Margins of keels raised in front and behind as well as laterally; the lateral margins more thickened, the thickened greatest about cores, which are sunk in the lateral edge, the thickening decreasing gradually each way from this. All anterior corners rounded. The posterior corners rectangular back to the fourteenth segment, inclusive. Caudal corners of fifteenth and sixteenth keels a little broadly produced, those of seventeenth more produced, and those of eighteenth strongly so, while those of the nineteenth are much smaller and narrower, though also strongly produced (see pl. 22, figs. 4 and 5). Margins wholly smooth. Metatergites with only a very shallow transverse depression; the entire surface finely granular, with a series of well-separated, larger granules along caudal margin and one of a few, much more widely separated granules across anterior border. Anal tergite triangular. distally narrowly truncate, and on truncate surface bearing four setae. Anal valves margined; surface a little rugose and with fine granules like those of dorsum (pl. 22, fig. 5).

Anal scale triangular, the caudal angle a little rounded (pl. 22, fig. 6).

Legs very long, extending widely beyond the sides of the body. Proportions of joints as shown in plate 23, figure 2.

Gonopods as represented in plate 23, figures 3 and 4.

Length, 24 mm.; width, 3.6 mm.

Locality.—Guatemala: San Rafael, five males (O. F. Cook, June 4, 1914).

Type.—Cat. No. 854, U.S.N.M.

Genus ACERATOPHALLUS Carl.

134. ACERATOPHALLUS UNICOLOR Carl.

Aceratophallus unicolor Carl, Rev. Suisse Zool., 1902, vol. 10, p. 609, pl. 2, figs. 35, 36.—Brölemann, Ann. Soc. Ent. France. 1905, vol. 74, p. 345, pl. 8, figs. 6, 7.—Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 182, pl. 14, fig. 2.

Localities.—Costa Rica: San José, La Uruca.

135. ACERATOPHALLUS LAMELLIFER Brölemann.

Aceratophallus unicolor lamellifer Brölemann, Ann. Soc. Ent. France, 1905, vol. 74, p. 346, pl. 8, figs. 1–5.

Aceratophallus lamellifer Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 183.

Locality.—Costa Rica: San José.

136. ACERATOPHALLUS DUX Chamberlin.

Aceratophallus dux CHAMBERLIN, Trans. Amer. Ent. Soc., 1914, vol. 40, p. 193, pl. 2, fig. 11.

Locality.—Costa Rica: Juan Viñas.

Genus HOLISTOPHALLUS Silvestri.

137. HOLISTOPHALLUS PEREGRINUS Silvestri.

Plate 23, figs. 5–9; plate 24, figs. 1–4.

Holistophallus peregrinus SILVESTRI, Boll. Mus. Zool. ed. Anat. comp. Torino, 1909, vol. 24, No. 615, p. 4, fig. III, 1–3.

Localities.—Guatemala: Quirigua, one male (W. M. Wheeler); Cacao Trece Aguas, one male (G. P. Goll, March, 1907); Honduras: Progreso, one male; San Juan Pueblo, two males (W. M. Mann).

This species was originally described from Tabasco, Mexico. The several specimens now studied agree in all essentials with the description of the type, though presenting considerable variations among themselves in some details. Variations in the form of the anal scale are shown in the figures (pl. 23, figs. 8, 9; pl. 24, figs. 1, 2).

Family SPHAERIODESMIDAE.

Genus SPHAERIODESMUS Peters.

138. SPHAERIODESMUS HONDURASANUS, new species.

Plate 14, figs. 8–10; plate 15, figs. 1, 2.

The general color in the types is pale greenish yellow; but in some the body appears ferruginous because of a closely adherent layer of foreign material, which gives it a dull, lusterless appearance. The surface itself, however, when cleaned is shining, though marked irregularly with coriarious impressions. Collum wider than the head, acutely narrowing laterad on each side, narrowly rounded at apices of angles; posterior margin convex, the anterior margin more nearly straight. The second plate much shorter than the third; both second and third plates crescentic, the keels narrowed distad. Fourth plate with keels much wider, though only slightly wider distally than proximally; the anterior margin weakly convex, the posterior one weakly concave; anterior angle widely rounded, the posterior one more narrowly rounded, its general outline subrectangular. Keel of fifth segment much narrower than that of fourth, a little narrowed distad, being broader across base than across distal end; posterior angle more widely rounded than the anterior. Sixth and immediately succeeding plates with keels strongly narrowed

distad, in posterior region again becoming broader distally (see pl. 14, figs. 8 and 9). Hairs of legs rather sparse, shorter on dorsal than on ventral surface. In the male, the first leg is scarcely thickened and the femur has no node or process below.

The socket of the gonopods is limited behind and laterally by a continuous elevated rim; the socket not fully extending to the tubercle on each side. Distance between bases of legs about equalling the length of the seventh segment of the leg. Coxa of gonopod stout. Telopodites extending forward parallel to each other, distally curving upward and then caudad, uncate, pointed and undivided; on dorsal side near middle a long straight process as shown in the figures (see pl. 15, figs. 1 and 2).

Length, near 17 mm.; width, 5.5 mm.

Localities.—Honduras: San Juan Pueblo (type locality), seven specimens; Lombardia, three specimens (W. M. Mann).

Type.—Cat. No. 855, U.S.N.M.

139. SPHAERIODESMUS CORIACEUS Pocock.

Sphaeriodesmus coriaceus Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 125, pl. 9, figs. 4–4*h*.

Locality.—Guatemala: San Juan in Alta Vera Paz.

140. SPHAERIODESMUS MEDIUS Carl.

Sphaeriodesmus medius Carl, Rev. Suisse Zool., 1902, vol. 10, p. 675, pl. 12, figs. 105, 106.

Locality—Guatemala.

141. SPHAERIODESMUS DIGITATUS Pocock.

Sphaeriodesmus digitatus Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 124, pl. 9, figs. 3–3*d*.

Locality.—Guatemala: Volcan de Agua.

Genus EUSPHAERIODESMUS Brölemann.

142. EUSPHAERIODESMUS ANGUSTUS (Pocock).

Sphaeriodesmus angustus Pocock, Biol. Centr.-Amer., Diplop., p. 123, pl. 9. figs. 1–1*g*.

Locality.—Guatemala: Senahu in Alta Vera Paz.

143. EUSPHAERIODESMUS STILIFER (Pocock).

Sphaeriodesmus stilifer Pocock, Biol. Centr.-Amer., Diplop., 1909, p. 124, pl. 9, figs. 2–2*c*.

Locality.—Costa Rica: Irazu.

Genus CYLIONUS Cook.

144. CYLIONUS CONSTRICTUS Pocock.

Cylionus constrictus POCOCK, Biol. Centr-Amer., Diplop., 1909, p. 127, pl. 9, figs. 5–5*f*.

Locality.—Guatemala: Volcan de Agua.

Genus COLOBODESMUS Brölemann.

145. COLOBODESMUS BIOLLEYI Brölemann.

Colobodesmus biolleyi BRÖLEMANN, Ann. Soc. Ent. France, 1905, vol. 74, p. 350, pl. 8, figs. 8–12; pl. 9, figs. 13, 14.

Locality.—Costa Rica: San José, Caché, Cariblanco.

Family POLYDESMIDAE.

Genus PERIDONTODESMUS Silvestri.

146. PERIDONTODESMUS FLAGELLATUS Pocock.

Peridontodesmus flagellatus POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 136, pl. 10, figs. 4–4*g*.

Locality.—Guatemala: Cholhuitz.

147. PERIDONTODESMUS ELECTUS Chamberlin.

Peridontodesmus electus CHAMBERLIN, Trans. Amer. Ent. Soc., 1914, vol. 40, p. 188, pl. 2, fig. 2.

Locality.—Costa Rica: Juan Viñas, Cartago, many specimens taken in December, 1911 (W. M. Wheeler).

Family CRYPTODESMIDAE.

Genus CYNEDESMUS Cook.

This genus was proposed primarily for a species from Grand Canary; but as that species was not described the Cuban *Cryptodesmus ornamentatus* Karsch, which was included, must stand as the genotype. While in the absence of a knowledge of the gonopods of *C. ornamentatus* the matter can not be wholly certain, there is little doubt that this species is congeneric with certain other West Indian species, as for example the Haitian *caraibianus* Chamberlin and *granulofrons* Chamberlin, which were described under *Treseolobus*. These species do not seem to be generically distinct from the Mexican and Central American species described by Pocock under *Lophodesmus* in the Biologia. Cynedesmus is, in consequence, here adopted.

148. CYNEDESMUS CELATUS (Pocock).

Lophodesmus celatus POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 133, pl. 10, figs. 2–2*a*.

Localities.—Guatemala: Volcan de Agua, Joyabaj, three specimens (O. F. Cook, May, 1906).

149. CYNEDESMUS PERPARVUS (Pocock).

Lophodesmus perparvus POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 133, pl. 10, figs. 3–3*a*.

Locality.—Guatemala: Volcan de Agua.

Genus CYRTODESMUS Gervais.

150. CYRTODESMUS GRANOSUS (Gervais and Goudot).

Polydesmus granosus GERVAIS and GOUDOT, Ann. Soc. Ent. France, ser. 2, 1844, vol. 2, p. 28.

Cyrtodesmus granosus GERVAIS, Ins. Apt., vol. 4, 1847, p. 93.

Oncodesmus granosus POCOCK, Biol. Centr.-Amer., Diplop., 1909, p. 116.

Locality.—Panama.

Suborder ONISCOMORPHA.

Family GLOMERIDAE.

GLOMEROIDES, new genus.

Body strongly pigmented, composed of head and twelve segments. The last tergite large, greatly exceeding the eleventh in size, not furrowed or otherwise roughened. Antennae and ocelli as in *Glomeris*. Second tergite cleft below from caudal margin, the hyposchismal portion of plate concealed in dorsal view. Telopodite of male gonopods with a stout, distally directed process on mesal side of tibia, the femur lacking processes; without setigerous cones or papillae or setae. Seventeenth legs of male greatly reduced, with only three joints beyond coxa; clawless. Eighteenth legs of male with coxae separated by a distinct suture at middle; six-jointed; the tarsus about twice as long as the tibia.

Genotype.—*Glomeroides centralis*, new species.

Differs from *Glomeris* and resembles *Onychoglomeris* in form of gonopods in male, but differs from the latter in the reduced, clawless seventeenth legs, etc.

151. GLOMEROIDES CENTRALIS, new species.

Plate 24, figs. 5–8; plate 25, figs. 1–4.

Typically black or bluish black above, with a median longitudinal fulvous line running caudal from collum. This expands triangularly on anterior portion of each tergite and forms a broader band on the twelfth tergite. Also typically a series of vertically elongate, pale spots along each side, each spot with a network of fine dark lines visible under lens. Collum with a yellow caudal margin bordered in front with a dark band, the plate paler in front of this. Pleurites fulvous, the sternites and legs often a little darker. An-

tennae brown. Head fulvous below, brownish above. Collum with caudal and lateral margins forming an evenly convex curve, margined all around. The more caudal of the two transverse sulci a little in front of middle, nearer to the second sulcus than the latter is to the anterior margin (pl. 25, fig. 3). Second tergite margined below and entirely across anterior border. Behind margining slucus with numerous parallel striae, much as in *G. multistriatus* (C. Koch) (pl. 24, fig. 5). In the following tergites the keels acutely narrowed ventral, with lower ends rounded. The anterior field on these tergites is narrow, less than half the width of the posterior, and without sulcus, as shown in plate 24, figure 5.

Seventeenth, eighteenth, and nineteenth (gonopodal) legs of male as shown in plate 24, figures 7 and 8, and plate 25, figures 1 and 2.

A pleurite from middle region is shown in plate 25, figure 4.

Length of female, 10 mm.; width, 6.5 mm. Length of male, 7 mm.; width, 4 mm.

Locality.—Guatemala: Trece Aguas (O. F. Cook, July 6, 1907).

Type.—Cat. No. 856, U.S.N.M.

The median dorsal fulvous stripe appears not to be developed as a rule in young specimens.

Suborder LIMACOMORPHA.

Family GLOMERIDESMIDAE.

Genus GLOMERIDESMUS Gervais.

152. GLOMERIDESMUS CENTRALIS, new species.

Plate 25, figs. 5, 6.

The general color above is brownish black, sometimes lighter. Head yellowish at sides and over lower part of clypeus, elsewhere dark but with an angular yellow mark between antennae, and above this a pair of yellow spots. Dorsum with a median longitudinal series of yellow spots, which are often divided, and a series on each side of this. A row of yellow spots below on each side.

In general structure and details of head, tergites, legs, and pleurites so closely corresponding to *G. porcellus* Gervais and Goudot of Colombia and Venezuela that a redescription is unnecessary. The form of the angles of the posterior tergites is shown in plate 25, figure 5.

This species seems obviously distinct from *porcellus* in the form of the penes. In *porcellus* the extended penes in all specimens examined are long and comparatively slender, with a marked tendency to curve, the curvature commonly more pronounced in one than in

the other. In the present species the penes are shorter and notably stouter and are straight. The penes are similarly longitudinally channeled and encircled by wrinkles, but the latter are less pronounced. The two posterior channels end farther proximad from tip, the distal end of the ridge between them forming a notch well removed from the free end, which is conically rounded (see pl. 25, fig. 6).

Length, 7 to 8 mm.

Locality.—Guatemala: Actele, many specimens (O. F. Cook, May 2, 1906).

Type.—Cat. No. 862, U.S.N.M.

Three young females taken in June, 1907, may be this species, but can not be determined with certainty.

EXPLANATION OF PLATES.

Drawn by the author.

Plate 1.

Platydesmus interruptus, new species.

Fig. 1. Anterior end in outline, dorsal view × 22.5.
2. Posterior end in outline, dorsal view × 22.5.

Desmethus setifer, new species.

3. Anterior end, dorsal view × 22.5.
4. Head, anterior view × 22.5.
5. Posterior end, dorsal view × 22.5.
6. Gnathochilarium × 27.
7. Right posterior gonopod, anterior view × 77.
8. Left anterior gonopod, anterior view × 77.

Plate 2.

Siphonophora barberi, new species.

Fig. 1. Anterior end, dorsal view × 47.5.
2. Pleurite, from anterior region × 100.
3. Pleurite, from posterior region × 100.
4. Gonopod of anterior pair × 200.
5. Gonopod of posterior pair × 200.

Siphonophora telana, new species.

6. Anterior end, dorsal view × 47.5.
7. Pleurite, from anterior region × 100.
8. Pleurite, from posterior region × 100.

Plate 3.

Siphonophora fallens, new species.

Fig. 1. Anterior end, dorsal view × 47.5.
2. Pleurite of one of most anterior segments × 100.
3. Pleurite from a posterior segment × 100.
4. An anterior gonopod × 225.

Siphonophora progressor, new species.

5. Anterior end, dorsal view × 47.5.
6. Anterior gonopod × 200.
7. Posterior gonopod × 200.

PLATE 4.

Siphonophora progressor, new species.

FIG. 1. Pleurite of anterior region×100.
2. Pleurite of posterior region×100.

Prostemmiulus relictus, new species.

3. Head and first tergites, lateral view×19.5.
4. First leg of male×33.
5. Second legs of male×33.
6. Third leg of male×33.
7. Gnathochilarium×33.
8. Antenna.
9. Anterior sternite of ninth segment×33.
10. Posterior sternite of ninth segment×33.
11. Gonopods, anterior view (tips of outer processes broken off)×48.
12. Gonopods, posterior view×48.

PLATE 5.

Prostemmiulus lombardiae, new species.

FIG. 1. Head and first tergites, lateral view×33.
2. Antenna×48.
3. Anterior sternite of tenth segment×77.
4. Posterior sternite of tenth segment, legs omitted×77.

Prostemmiulus cooki, new species.

5. Head and first tergites, lateral view×19.5.
6. First leg of male×33.
7. Second leg of male×33.
8. Third leg of male×33.
9. Anterior sternite of tenth segment×33.
10. Posterior sternite of tenth segment×33.
11. Gonopods of male, anterior view×48.
12. Posterior legs of seventh segment of male×33.

PLATE 6.

Cleidogona ceibana, new species.

FIG. 1. Tenth leg of male×33.
2. Eleventh leg of male×33.
3. Twelfth leg of male×33.
4. Process from between twelfth legs, ventral view×48.
5. Gonopods, anterior view×48.
6. Left gonopod, lateral view, with membranous appendage caudad of it×48.

Gymnostreptus lactus, new species.

7. Collum of male, lateral view×19.5.
8. Anal scale×19.5.
9. Gonopods of male, anterior view×19.5.

Gymnostreptus vagans, new species.

10. Collum of male, lateral view×19.5.

PLATE 7.

Gymnostreptus vagans, new species.

FIG. 1. Gonopods of male, type, anterior view×19.5.

Gymnostreptus pacificus, new species.

2. Collum of femals, lateral view×19.5.
3. Collum of male, lateral view×19.5.
4. Gonopods of male, anterior view×19.5.

Orthoporus absconsus, new species.

5. Collum of male, lateral view×19.5.
6. Anal scale×19.5.
7. Gonopods of male, anterior view×19.5.
8. Left gonopod, lateral view×19.5.

PLATE 8.

Orthoporus discriminans, new species.

FIG. 1. Collum of male, lateral view×19.5.
2. Anal scale×19.5.
3. Left gonopod of male, anterior view×19.5.
4. Left gonopod of male, ectal view×19.5.

Orthoporus cobanus, new species.

5. Collum of male, lateral view×19.5.
6. Gonopods of male, anterior view×19.5.
7. Right gonopod of male, ectal view×19.5.

Diaporus culebrae, new species.

8. Collum of male, lateral view×19.5.
9. Anal scale×19.5.

PLATE 9.

Diaporus culebrae, new species.

FIG. 1. Gonopods of male, anterior view×19.5.

Parajulus leucoclius, new species.

2. Collum, mandible, and first leg of male, lateral view×19.5
3. Caudal end of male, dorsal view×19.5.
4. Caudal end of male, lateral view.
5. Second legs of male, with processes×19.5.
6. Gonopods in situ, ventral view×27.5.
7. Gonopods, caudal view×27.5.
8. Left gonopods in situ, ectal view×27.5.

Rhinocricus nicaraguanus, new species.

FIG. 9. Upper part of caudal end, lateral view×8.
10. Anal scale×10.
11. Scobina of segment of middle region of body×19.5.

PLATE 10.

Rhinocricus wheeleri, new species.

FIG. 1. Caudal end, lateral view×19.5.
2. Anal scale×19.5.
3. Gonopods of male, anterior view (the right posterior omitted)×27.5.

Rhinocricus centralis, new species.

4. Anal scale×9.5.
5. Gonopods of male, anterior view×8.
6. Telopodite of posterior gonopod×19.5.

Rhinocricus simulans, new species.

7. Anal scale×9.5.
8. Scobina from segment of middle region of body×19.5.
9. Gonopods of male, anterior view×9.5.
10. Telopodite of posterior gonopod×19.5.

Oxypygides mesites, new species.

11. Caudal end, lateral view×9.5.
12. Anal scale×16.

PLATE 11.

Oxypygides mesites, new species.

FIG. 1. Gonopods of male, anterior view×16.
2. Telopodite of posterior gonopod×39.

Oxypygides lapidicina, new species.

3. Caudal end, lateral view×9.5.
4. Anal scale×19.5.
5. Scobina of segment of anterior region×19.5.
6. Anterior gonopods, anterior view×19.5.
7. Posterior gonopod×48.5.

Oxypyge ferruginopes, new species.

8. Caudal end, lateral view×9.5.
9. Anal scale×19.5.
10. Scobina of segment of middle region of body×48.5.
11. Gonopods of male, anterior view×19.5.
12. Telopodite of posterior gonopod×48.5.

PLATE 12.

Oxypyge confusa, new species.

FIG. 1. Scobina of segment of middle region of body ×48.5.
2. Gonopods of male, anterior view ×19.5.

Oxypyge socia, new species.

3. Scobina ×48.5.
4. Caudal end, lateral view ×19.5.
5. Gonopods, anterior view ×19.5.
6. Telopodite of posterior gonopod.

Oxypyge equalis, new species.

7. Caudal end, lateral view ×19.5.
8. Anal scale ×19.5.
9. Gonopods of male, anterior view ×19.5.
10. Telopodite of posterior gonopod ×48.5.

Oxobolus virilis, new species.

11. Seventh leg of male, caudal view ×8.
12. Anal scale ×8.

PLATE 13.

Oxobolus virilis, new species.

FIG. 1. Anterior gonopods of male, anterior view ×8.
2. Posterior gonopod, caudal view ×9.5.
3. Posterior gonopod, anterior view ×9.5,

Oxobolus cintus, new species.

4. Anal scale ×8.
5. Gonopods of male, anterior view ×8.
6. Right posterior gonopod, anterior view ×8.
7. Right posterior gonopod, posterior view.

Oxobolus cratus, new species.

8. Anal scale ×8.

Oxobolus pictus, new species.

9. Anal scale ×9.

Arolus purulanus, new species.

10. Anal scale ×48.5.
11. Gonopods of male, anterior view ×33.

Plate 14.

Arolus purulanus, new species.

Fig. 1. Telopodite of anterior gonopod, caudal view×72.
2. Posterior gonopod, mesal view×72.
3. Fourth leg of male, with ends of sternal processes×48.5.
4. Fifth leg of male×48.5.
5. Sixth leg of male×48.5.
6. Seventh leg of male×48.5.
7. Collum, lateral view×33.

Sphaeriodesmus hondurasanus, new species.

8. Anterior tergites, lateral view×9.5.
9. Caudal end, lateral view×9.5.
10. Caudal ventral margin of eighth segment×9.5.

Plate 15.

Sphaeriodesmus hondurasanus, new species.

Fig. 1. Gonopods of male, ventral view×48.5.
2. Gonopod, mesal view×48.5.

Oxypyge equalis, new species.

3. Scobina×48.5.

Nyssodesmus nigricaudus, new species.

4. Lateral portion of collum in outline, dorsal view×8.
5. Twelfth right keel×8.
6. Caudal end in outline, dorsal view×8.
7. Anal scale×16.
8. Left gonopod in situ, ventral view×16.

Nyssodesmus mimus, new species.

9. Twelfth keel, male type, in outline+8.
10. Anal scale×16.
11. Right gonopod, caudoventral view+16.

Plate 16.

Nyssodesmus nicaraguanus, new species.

Fig. 1. Twelfth right keel×8.
2. Anal scale×16.
3. Left gonopod, ventral view×16.
4. Right gonopod, ectal view×16.

Amplinus manni, new species.

FIG. 5. Anal scale×19.5.
6. Gonopods, ventral view×19.5.
7. Gonopods, ectal view×19.5.

Amplinus orphnius, new species.

8. Gonopods×19.5.

Amplinus niteus, new species.

9. Gonopods×19.5.

Chondrodesmus singularis, new species.

10. Fifth and sixth keels×16.
11. Tenth and eleventh keels×16.
12. Seventeenth and eighteenth keels×16.
13. Anal scale×19.5.

PLATE 17.

Chondrodesmus tuberculifer, new species.

FIG. 1. Third keel×9.5.
2. Eighth and ninth keels×9.5.
3. Fifteenth and sixteenth keels×9.5.
4. Anal scale, setae missing×19.5.
5. Gonopods of male, caudoventral view×33.
6. Leg of eighth segment, hairs omitted×9.5.

Chondrodesmus alidens, new species.

7. Tenth keel×9.5.
8. Fifteenth and sixteenth keels×9.5.
9. Anal scale×19.5.

Chondrodesmus panamenus, new species.

10. Last tergite, dorsal view, in outline, setae omitted×9.5.

PLATE 18.

Chondrodesmus panamenus, new species.

FIG. 1. Tenth and eleventh keels×9.5.
2. Seventeenth, eighteenth, and nineteenth keels×9.5.
3. Anal scale×16.

Aloeodesmus dromeus, new species.

4. Collum×9.5.
5. Anal scale×33.
6. Gonopods of male, ventral view×33.
7. Gonopods, distal portion, dorsal view×33.

Atylophor rafaelanus, new species.

FIG. 8. Caudal end of body, dorsal view×19.5.
9. Anal scale×33.
10. Leg of fifth segment, male×19.5.
11. Leg of seventeenth segment×19.5.

PLATE 19.

Atylophor rafaelanus, new species.

FIG. 1. Left gonopod of male, ventral view×48.5.
2. Left gonopod, ectal view×48.5.
3. Left gonopod, mesal view×48.5.

Schistides atopophallus, new species.

4. Antenna×19.5.
5. Eighth tergite×19.5.
6. Anal scale×33.
7. Leg of sixth segment of male×19.5.
8. Gonopods, ventral view×33.
9. Right gonopod, ectal view×33.

Tunodesmus orthogonus, new species.

10. Anal scale×31.

PLATE 20.

Tunodesmus orthogonus, new species.

FIG. 1. Head and collum, anterior view×16.
2. Head and collum, dorsal view×16.
3. Tenth left keel×19.5.
4. Caudal end, dorsal view×16.
5. Sternites of last two pediferous segments×33.
6. Antenna×19.5.
7. Seventh leg of male×19.5.
8. Leg of posterior region of male×19.5.
9. Right gonopod, anterior view×48.5.

PLATE 21.

Tunodesmus orthogonus, new species.

FIG. 1. Right gonopod, ectal view×48.5.
2. Right gonopod, posterior view.

Tunodesmus laminiger, new species.

3. Tenth keel×19.5.
4. Gonopod, posterior view×48.5.
5. Right gonopod, lateroectal view×48.5.

Synthodesmus simulans, new species.

6. Collum×19.5.
7. Tenth keel×33.
8. Anal scale×48.5.
9. Seventh leg of male×48.5.

PLATE 22.

Synthodesmus simulans, new species.

FIG. 1. Sternites of last two pediferous segments×48.5.
2. Gonopods of male, ventral view×77.

Curodesmus guatemalensis, new species.

3. Collum×19.5.
4. Tenth keel×19.5.
5. Caudal end of body, dorsal view×19.5.
6. Anal scale×48.5.

PLATE 23.

Curodesmus guatemalensis, new species.

FIG. 1. Antenna×27.5.
2. Leg from middle region of body×27.5.
3. Gonopods, caudoventral view×48.5.
4. Right gonopod, ectal view×48.5.

Holistophallus peregrinus Silvestri.

5. Collum, specimen from Guatemala×9.5.
6. Ninth keel of same×16.
7. Caudal end×9.5.
8. Anal scale×19.5.
9. Anal scale of another specimen from Guatemala×19.5.

PLATE 24.

Holistophallus peregrinus Silvestri.

FIG. 1. Anal scale, specimen from Honduras×19.5.
2. Anal scale, another specimen from Honduras×19.5.
3. Leg of ninth segment, specimen from Guatemala×16.
4. Gonopods, anterior view, specimen from Honduras×33.

Glomeroides centralis, new species.

5. Anterior end, lateral view, female×19.5.
6. Caudal end, lateral view, female×19.5.
7. Seventeenth leg of male×48.5.
8. Nineteenth leg of male, lateral view×98.5.

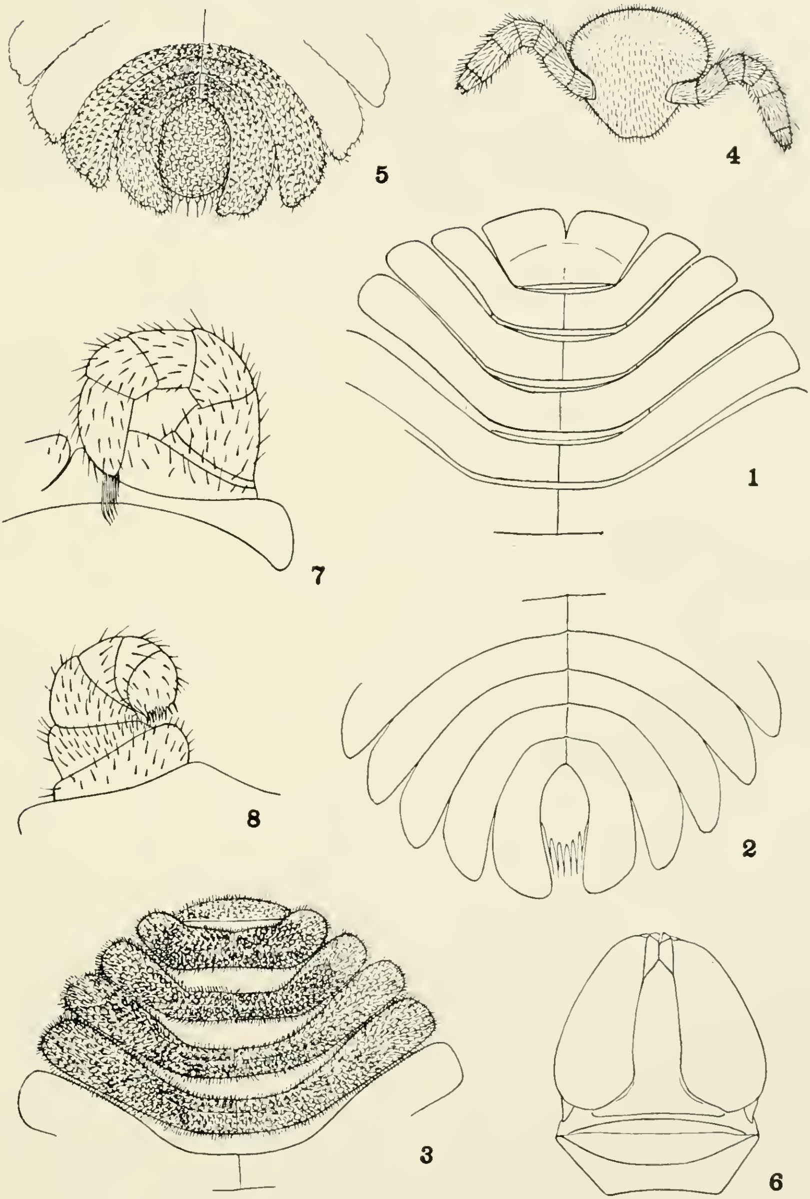
PLATE 25.

Glomeroides centralis, new species.

FIG. 1. Eighteenth leg of male×98.5.
2. Nineteenth leg and sternite of male×98.5.
3. Collum, female×19.5.
4. Pleurite from middle region of body, female×48.5.

Glomeridesmus centralis, new species.

5. Caudal end, lateral view.
6. Penes of male, with legs, anterior view×48.5.



THE MILLIPEDS OF CENTRAL AMERICA.

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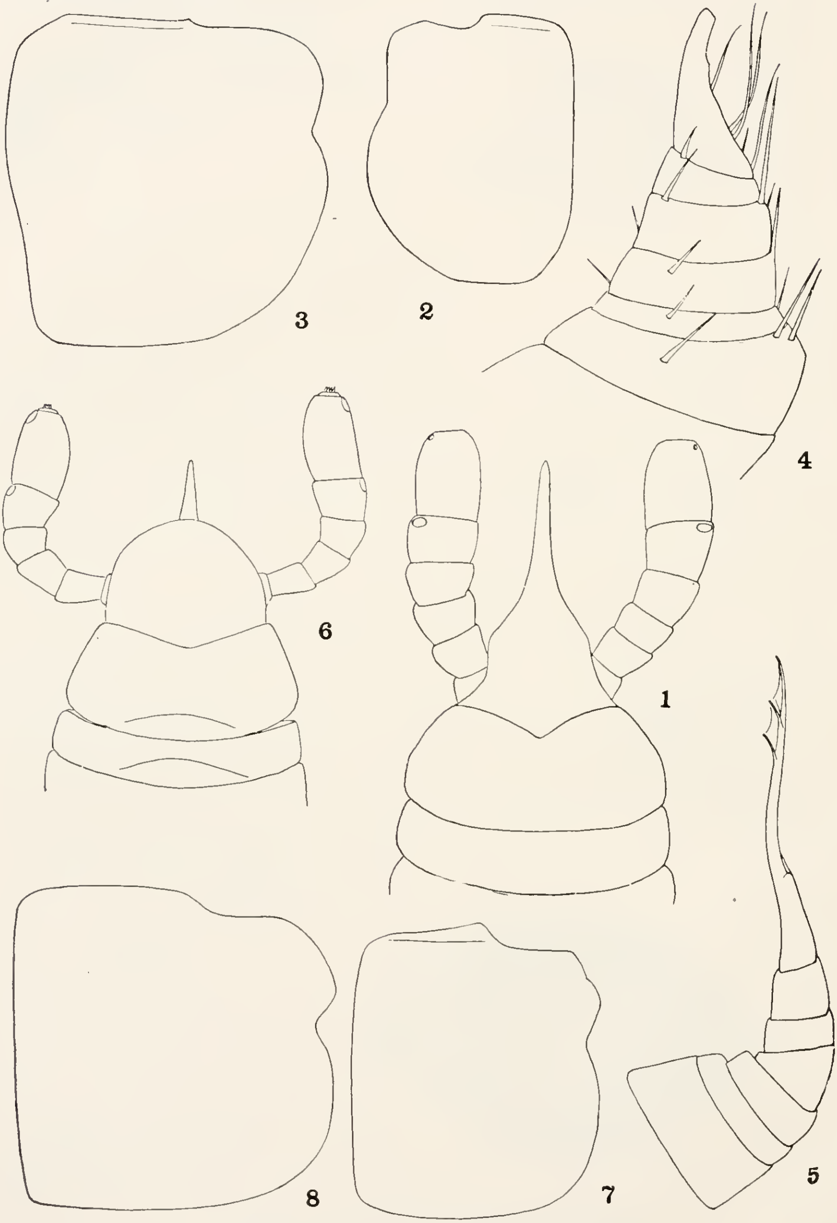

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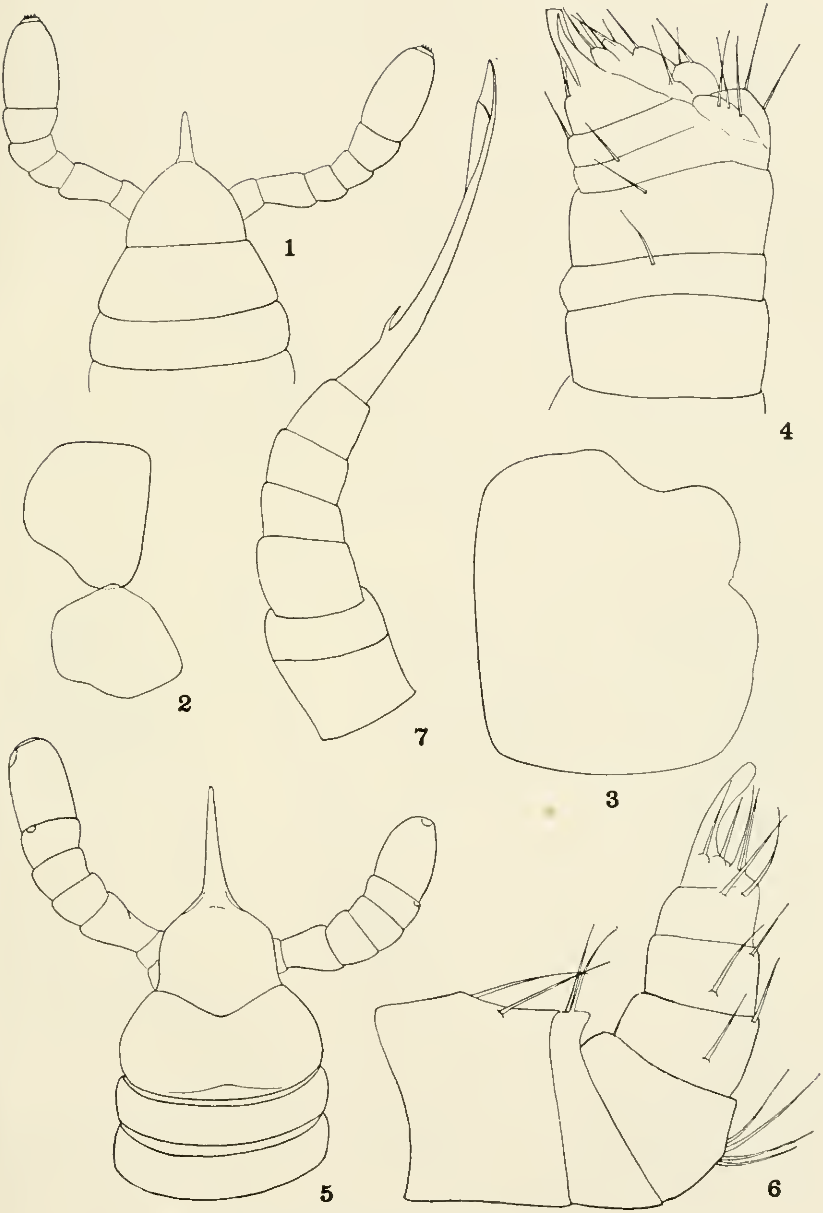

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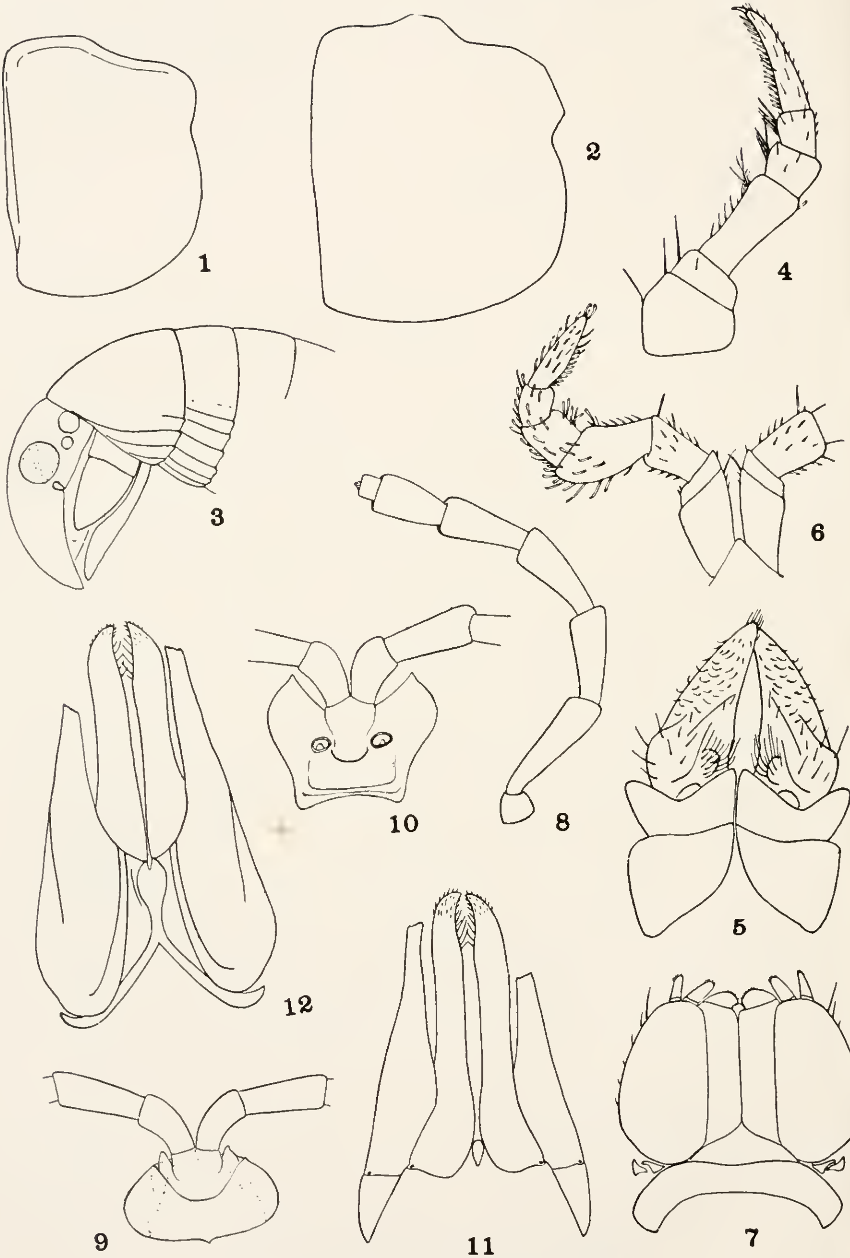

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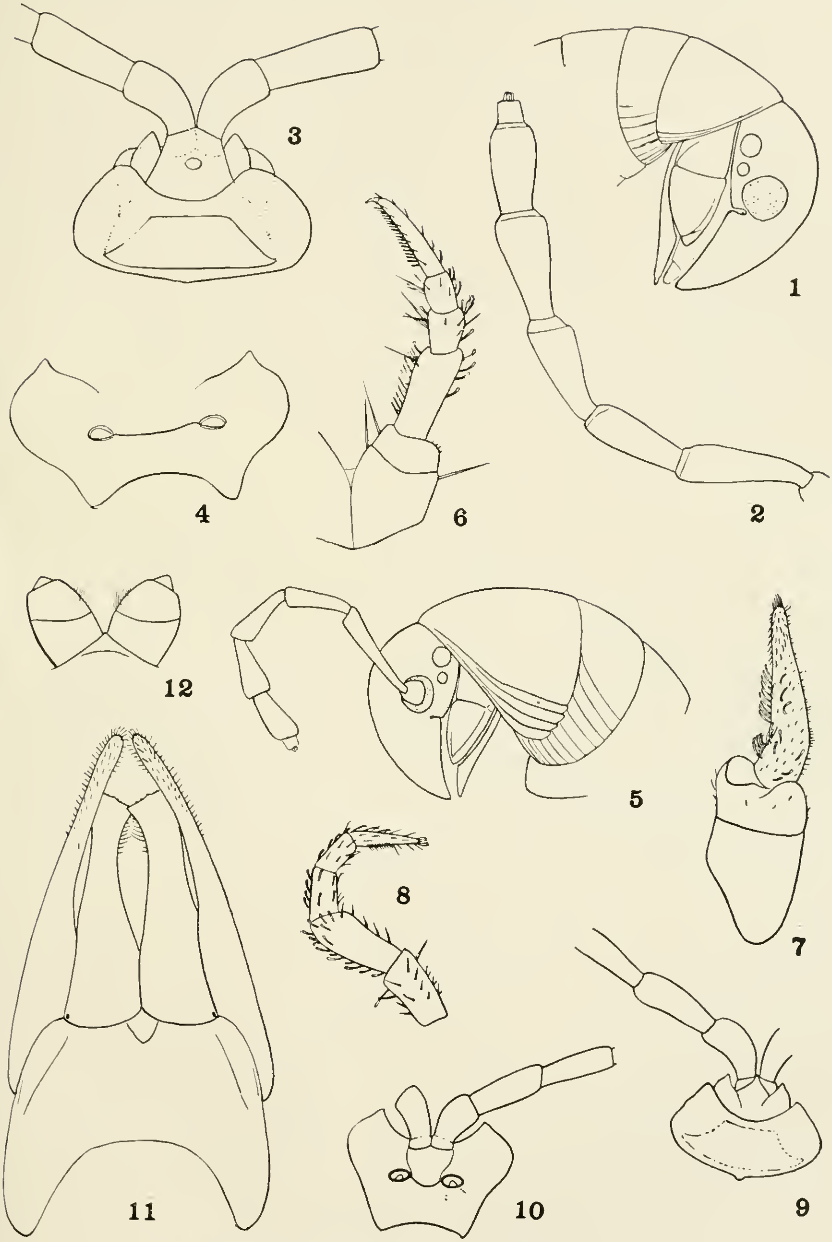

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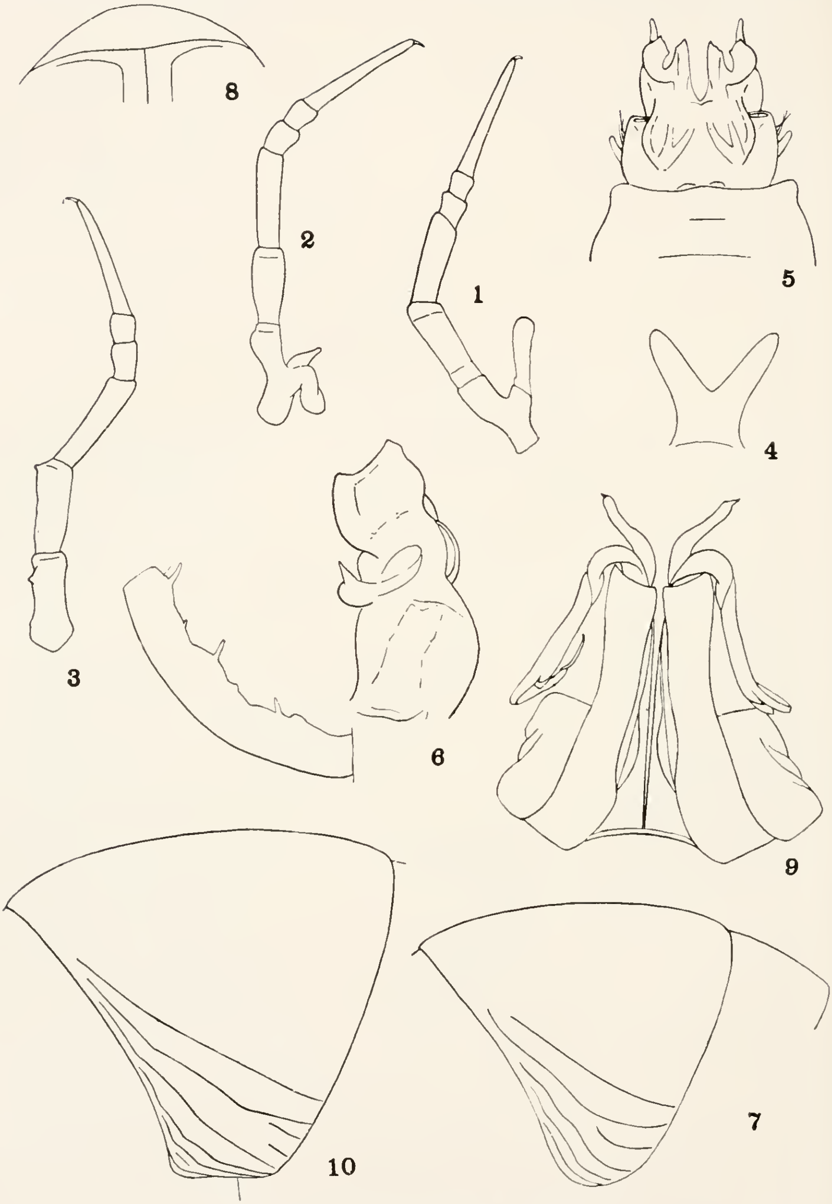

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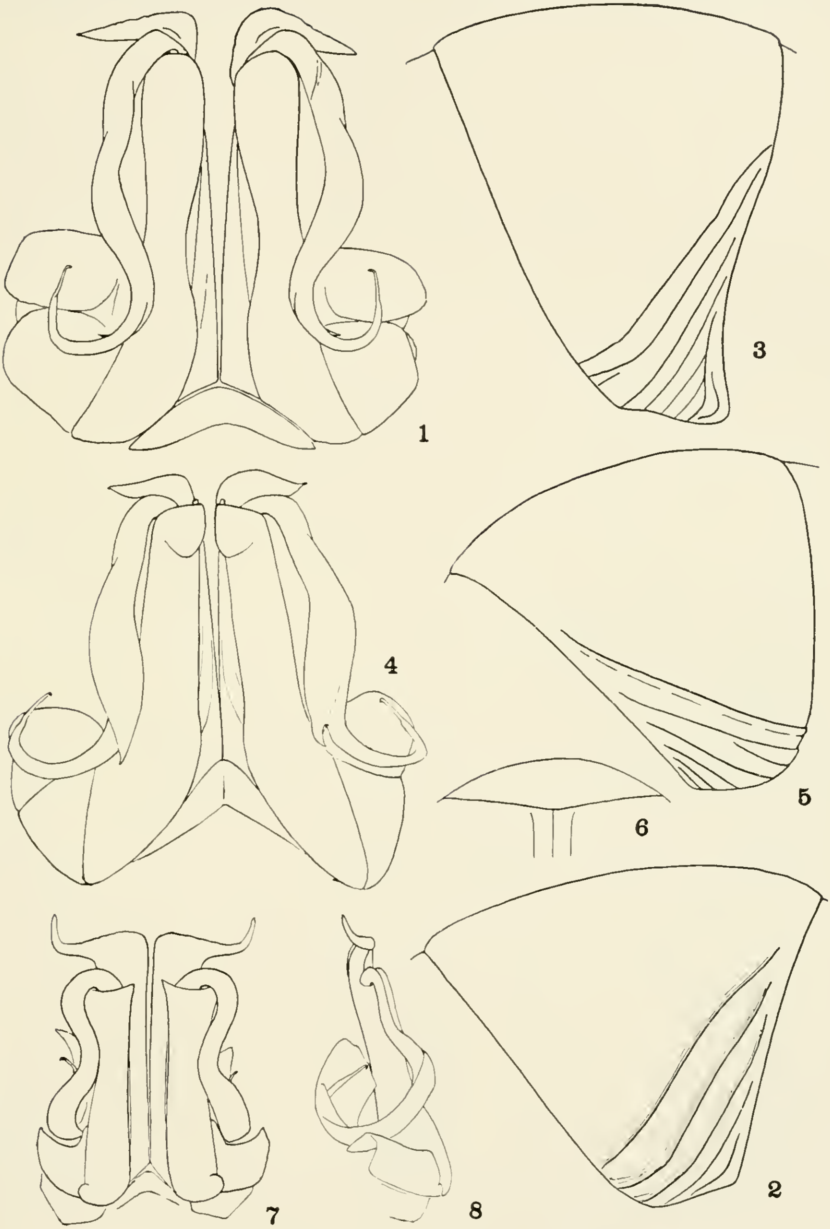

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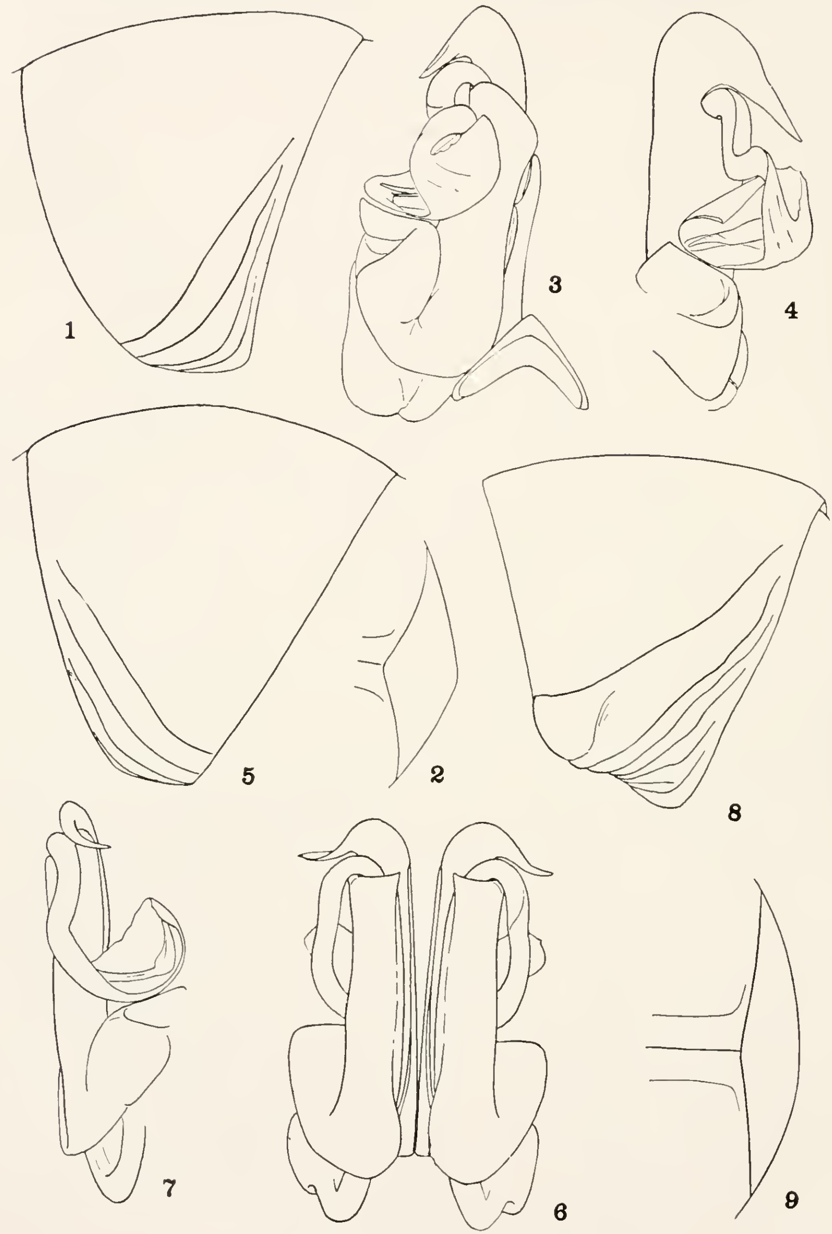

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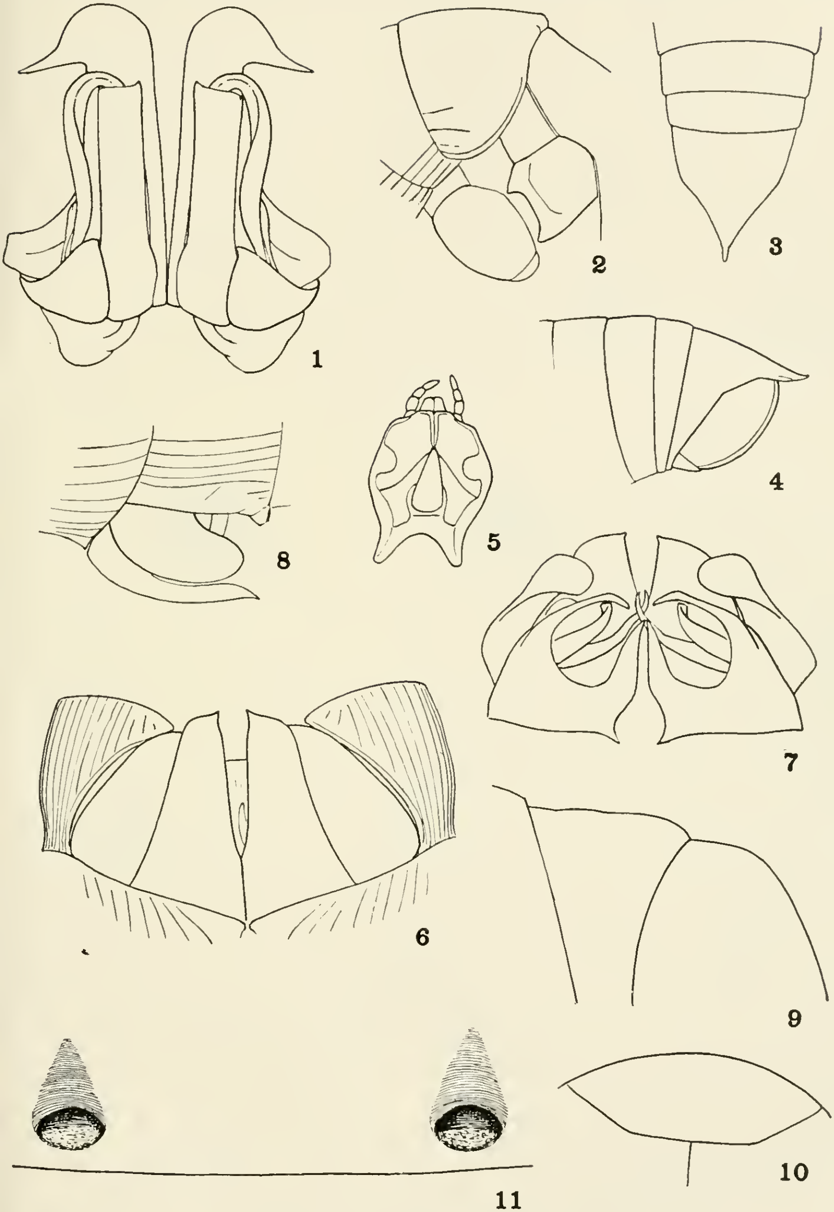

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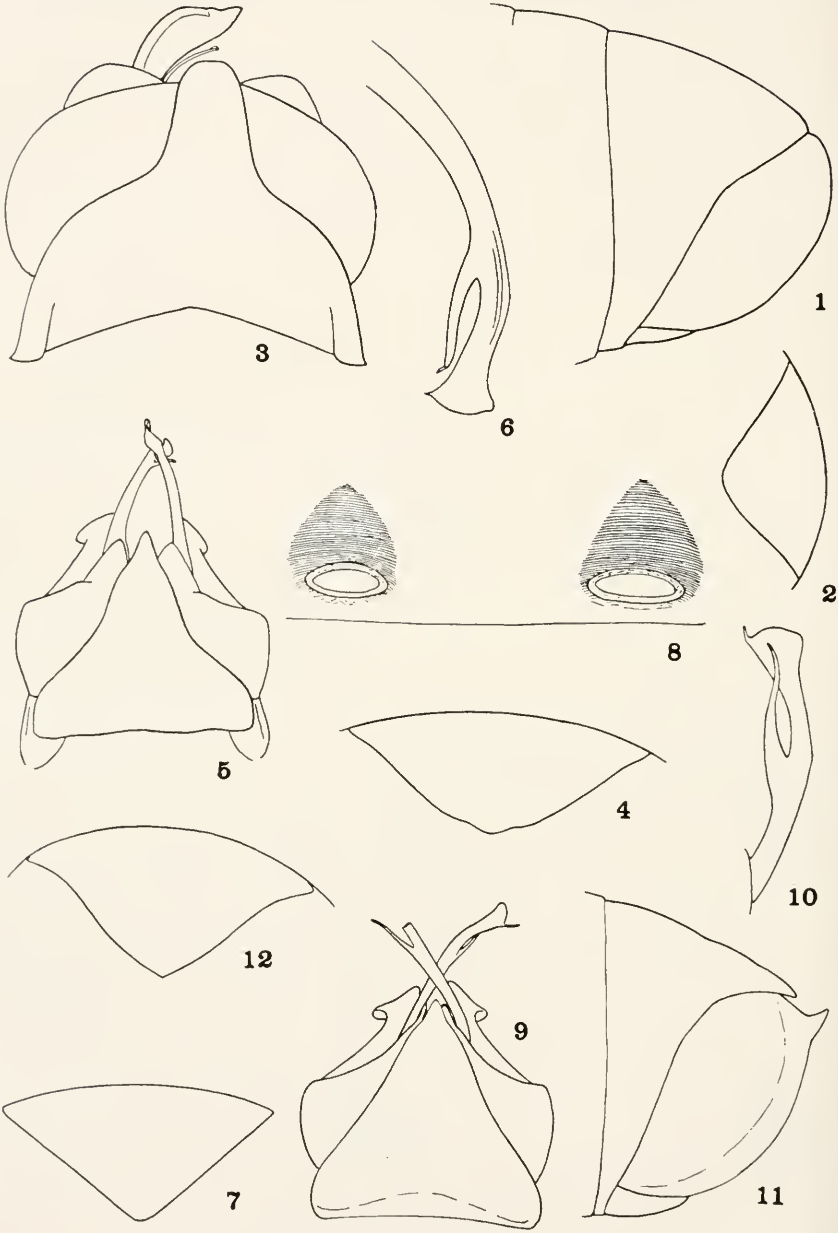
FOR EXPLANATION OF PLATE SEE PAGES 65 AND 69.



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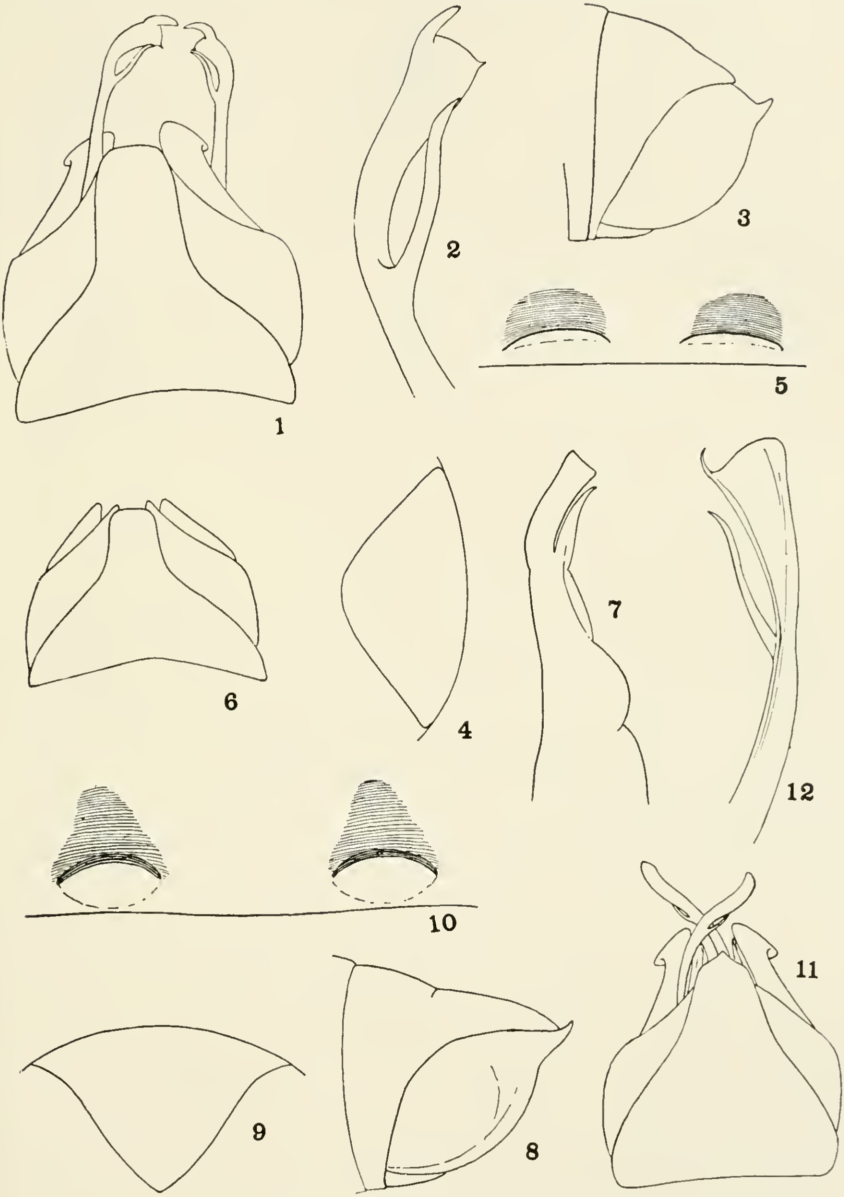

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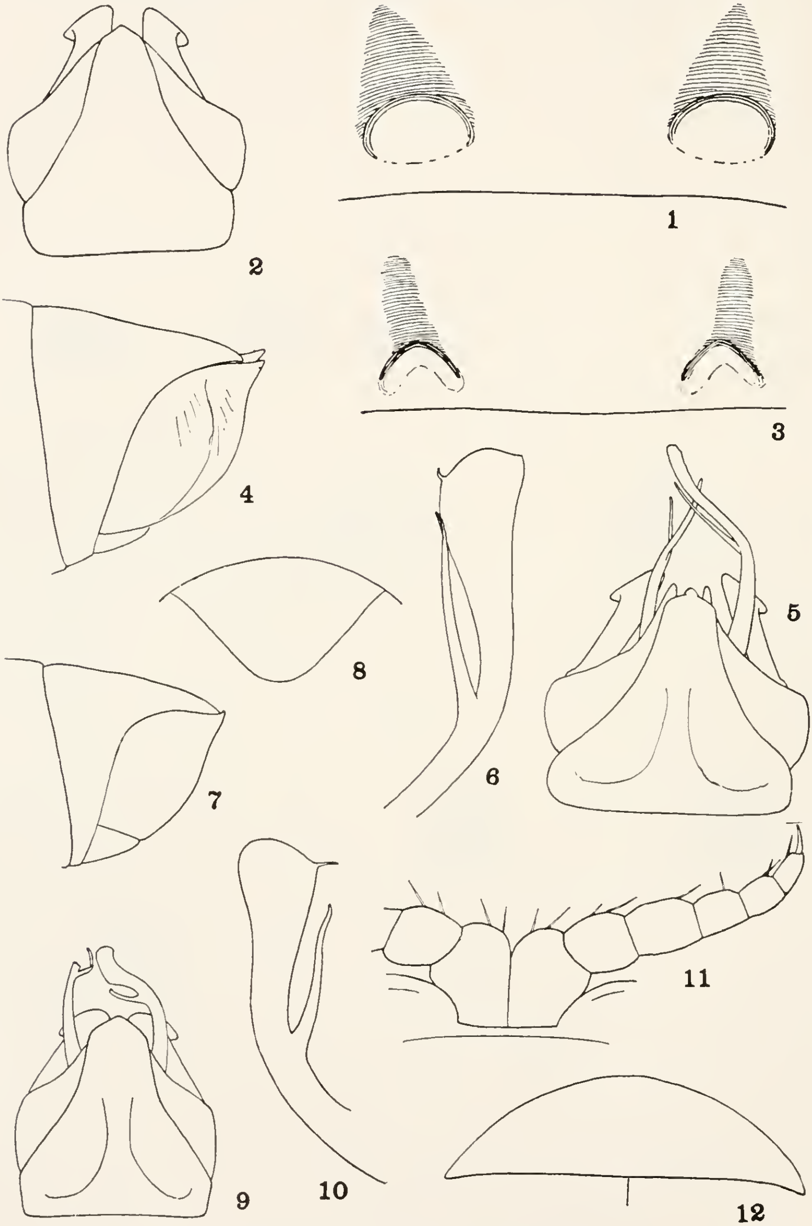

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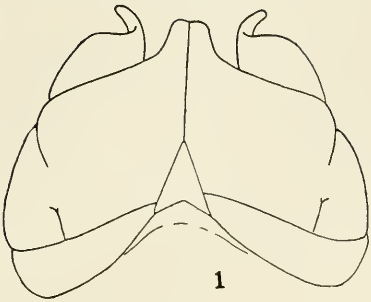
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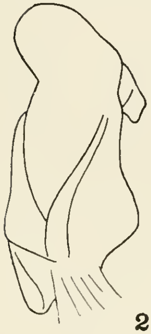
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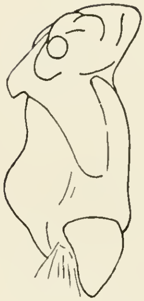
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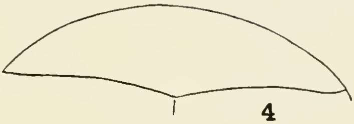
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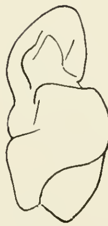
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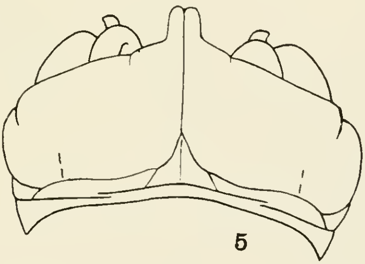
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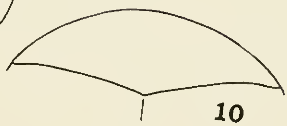
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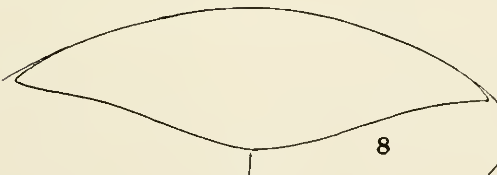
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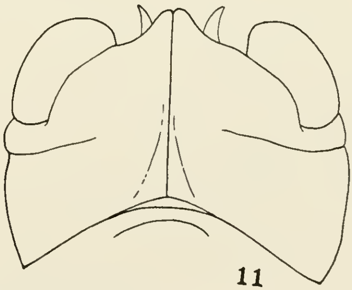
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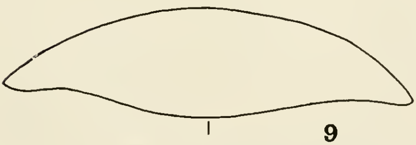
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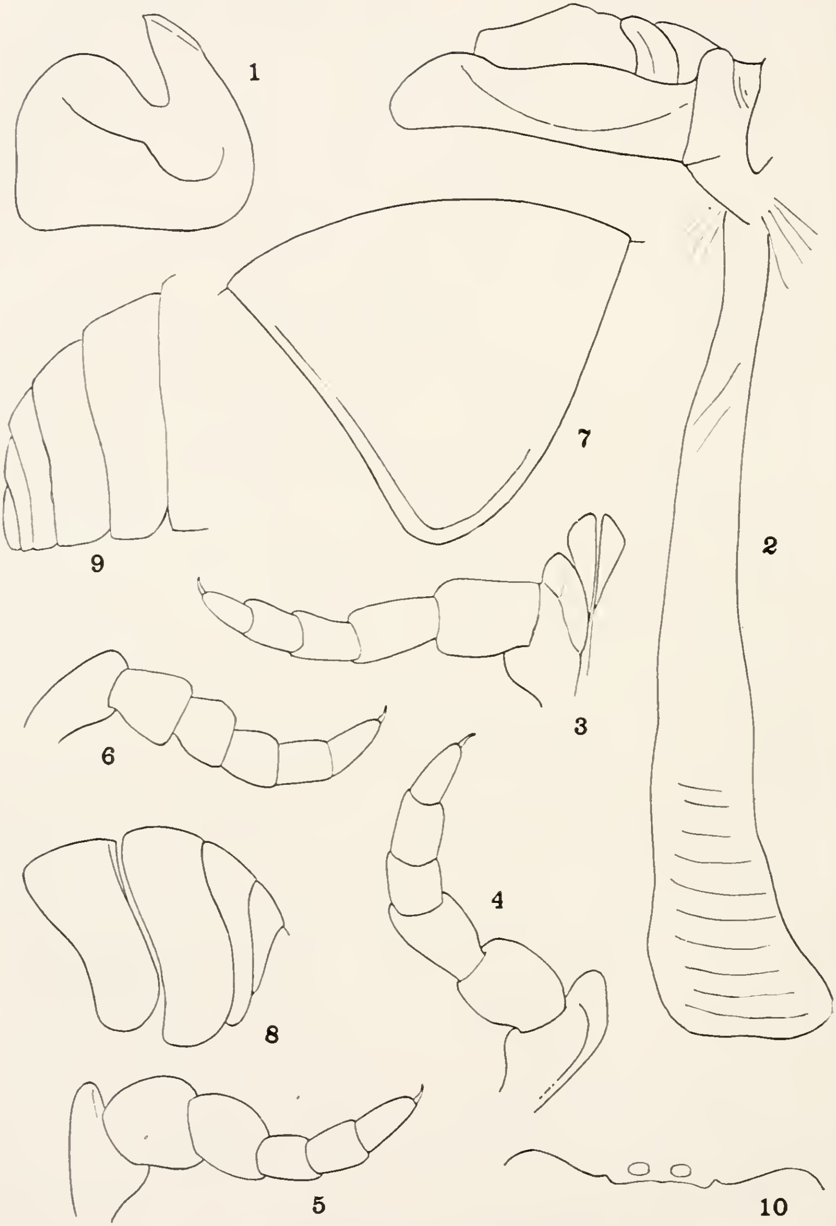

THE MILLIPEDS OF CENTRAL AMERICA.

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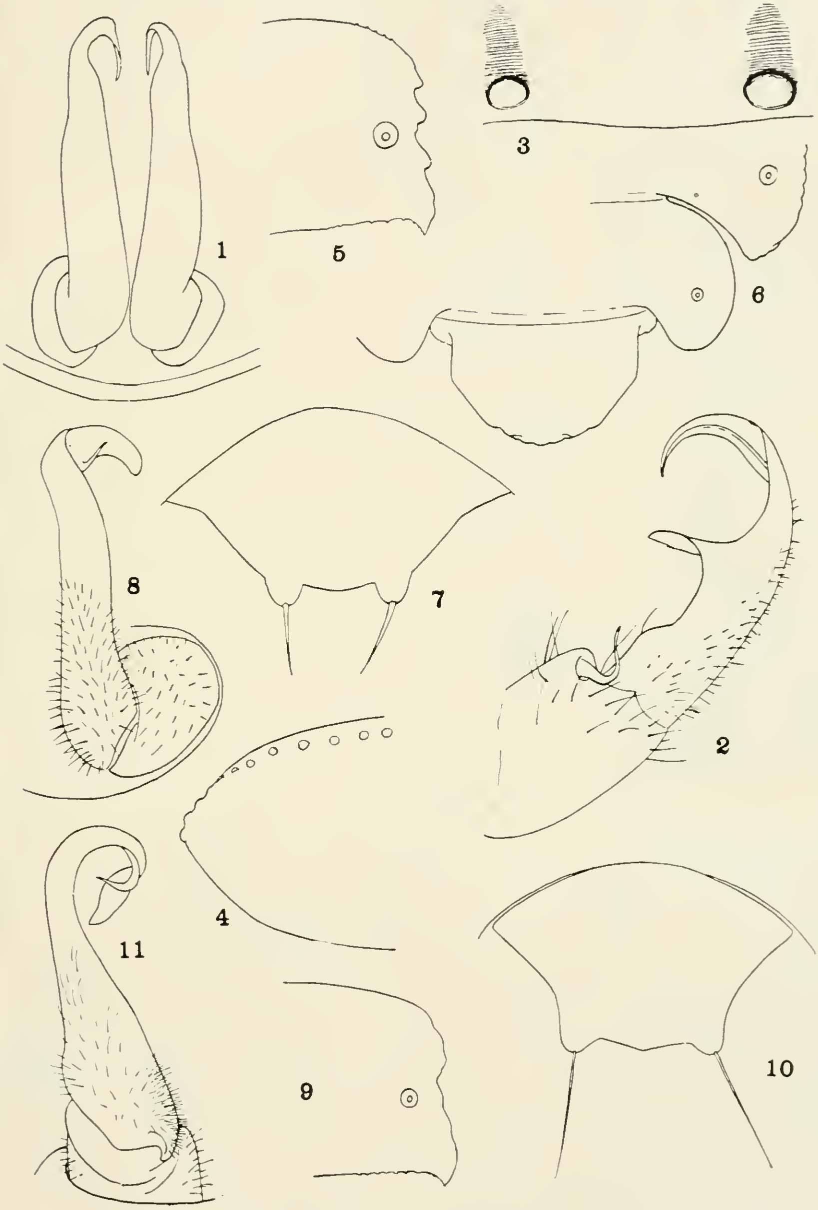

THE MILLIPEDS OF CENTRAL AMERICA.

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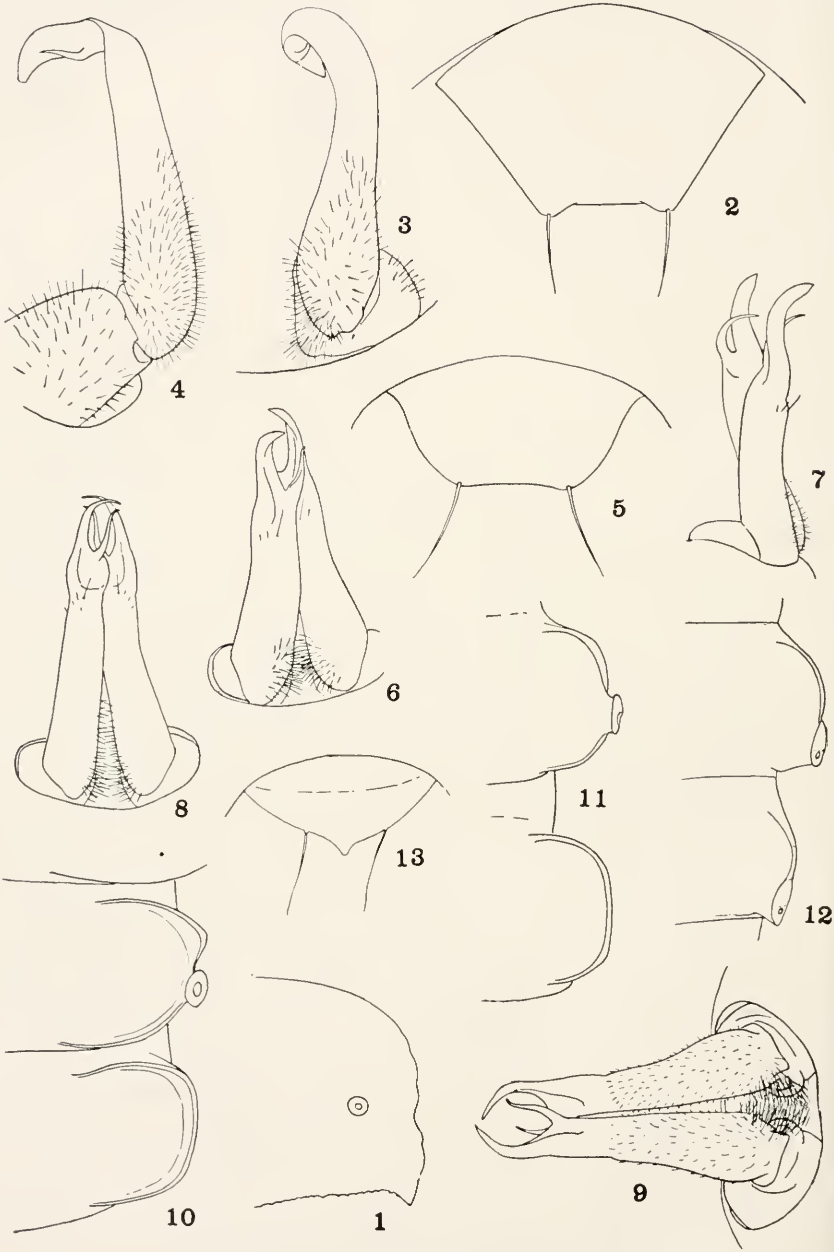
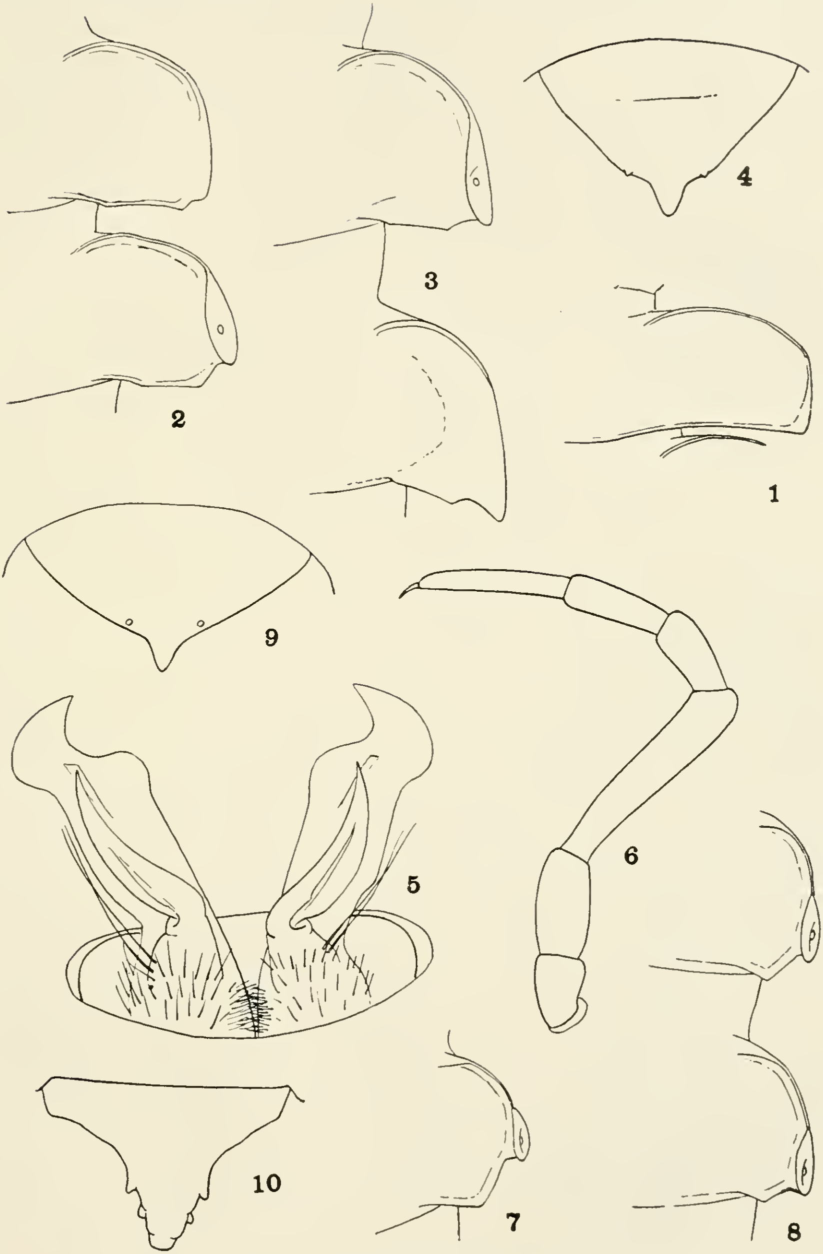


THE MILLIPEDS OF CENTRAL AMERICA.

FOR EXPLANATION OF PLATE SEE PAGES 68 AND 69.



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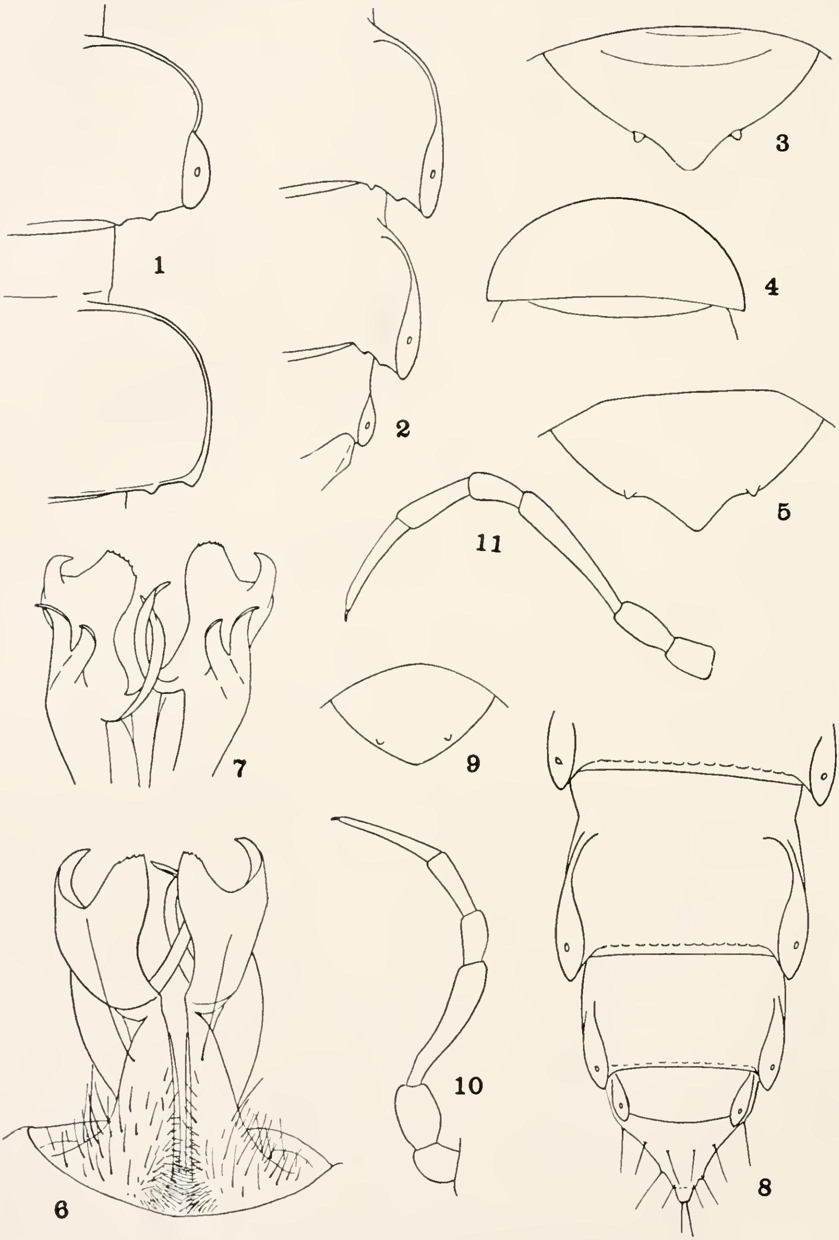

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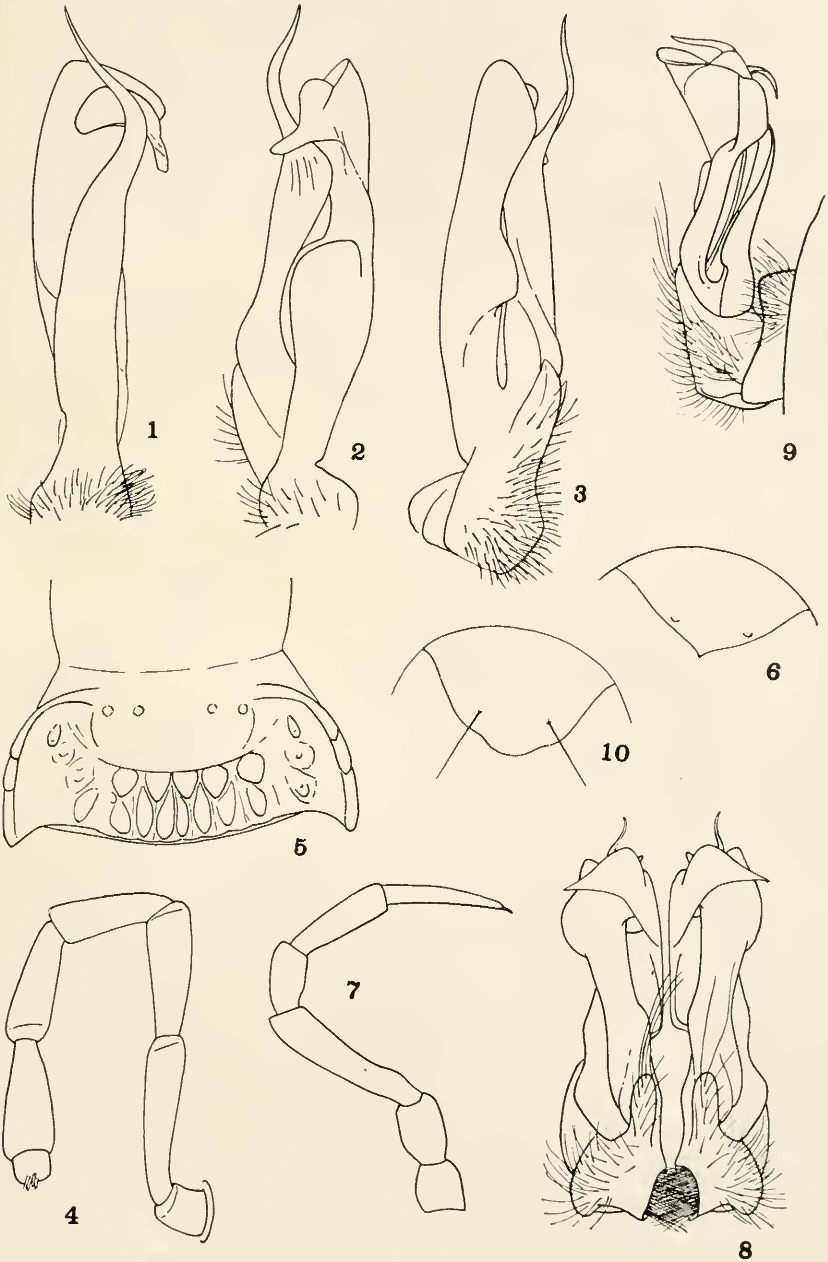

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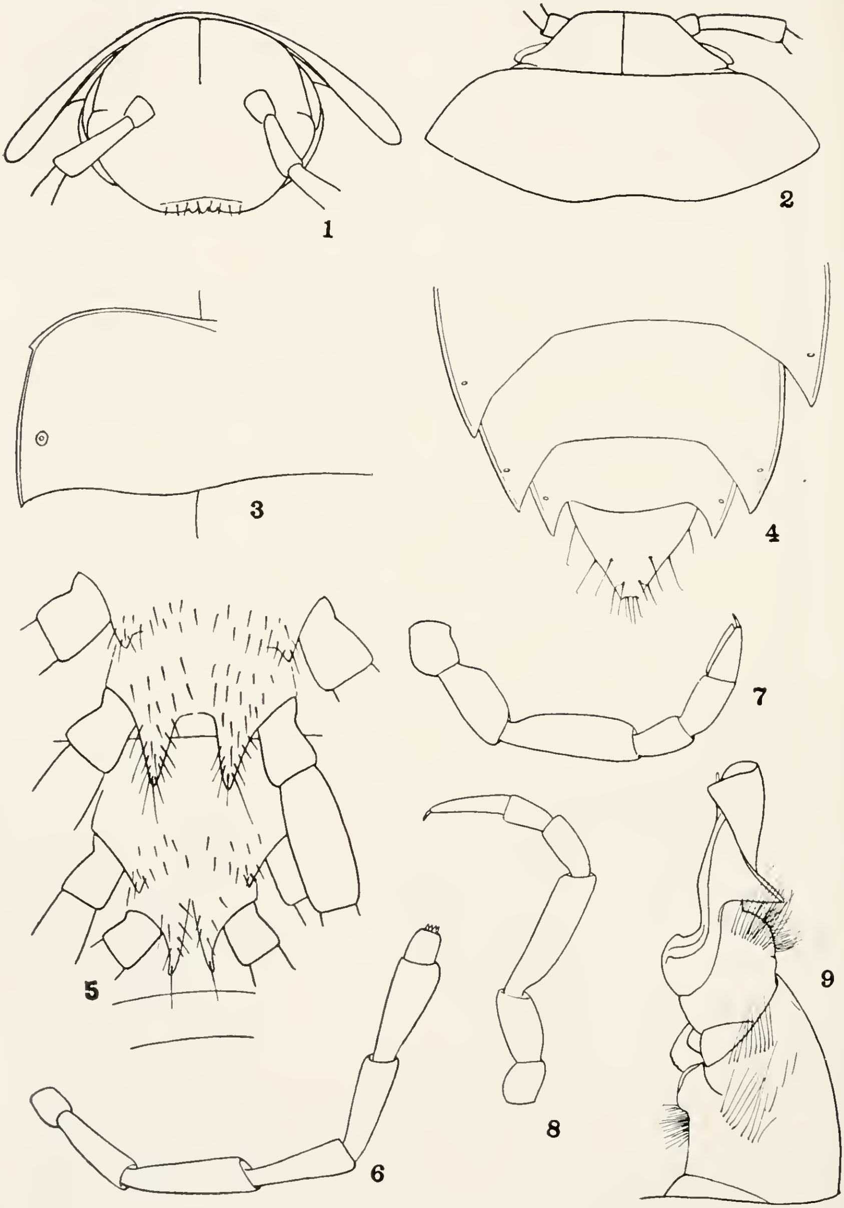

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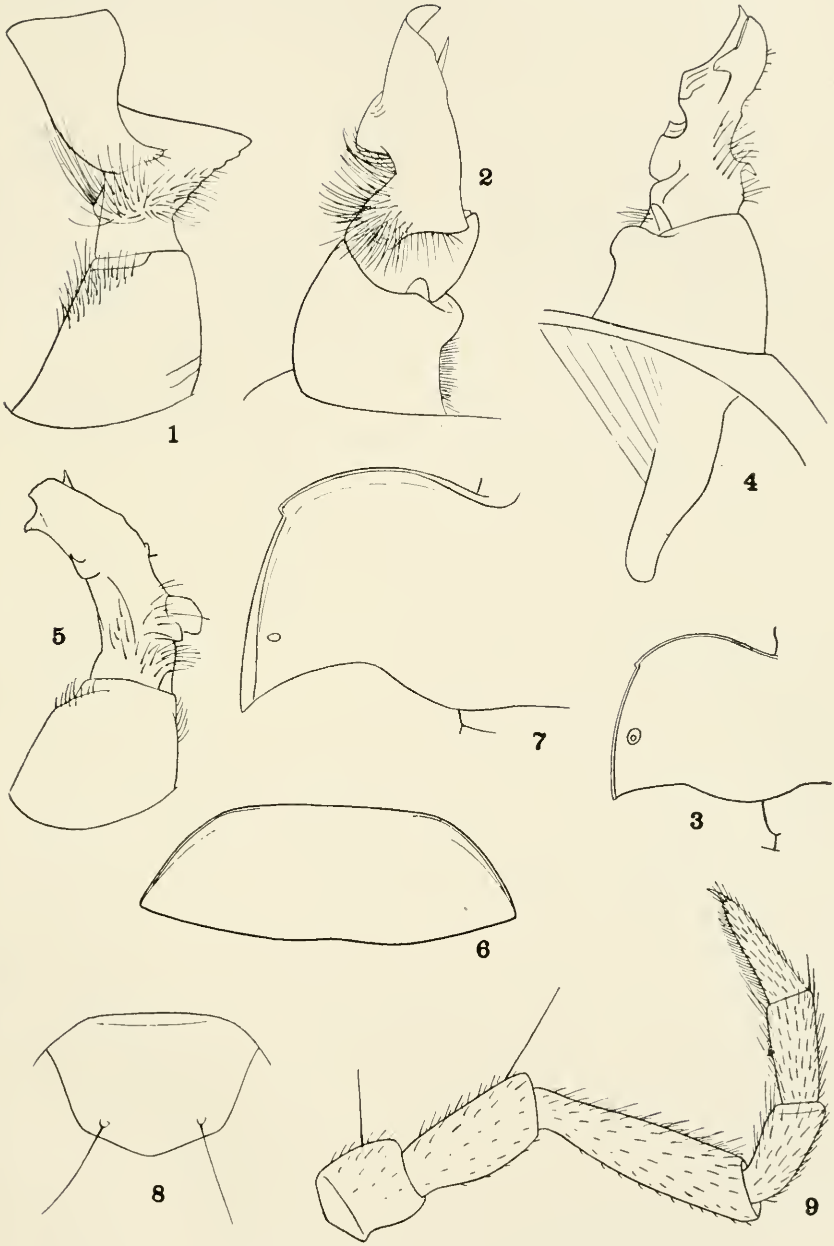

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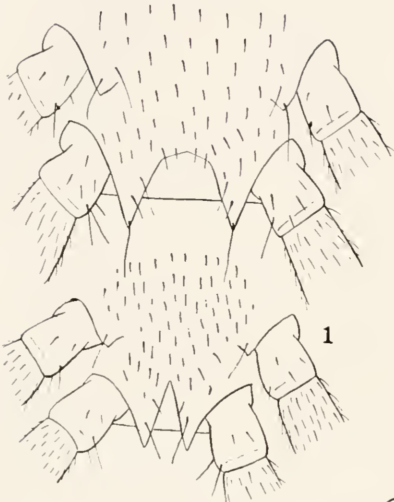

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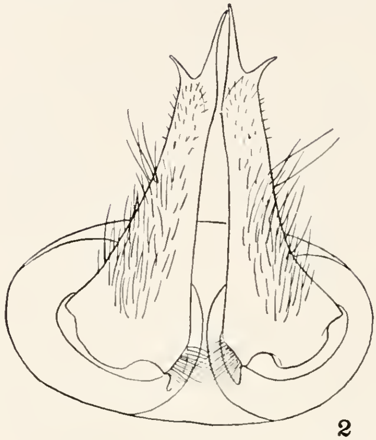

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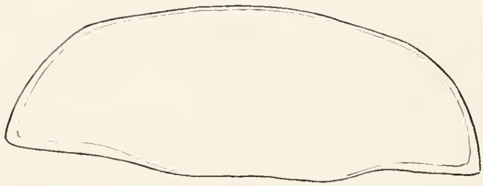

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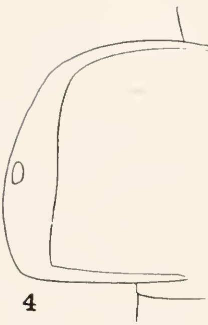

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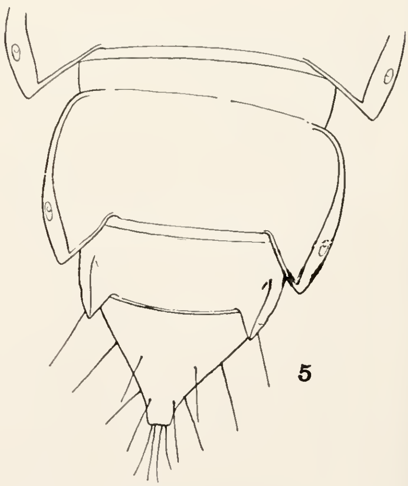

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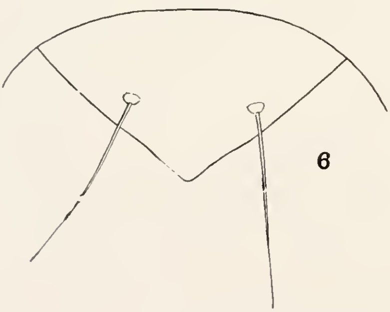

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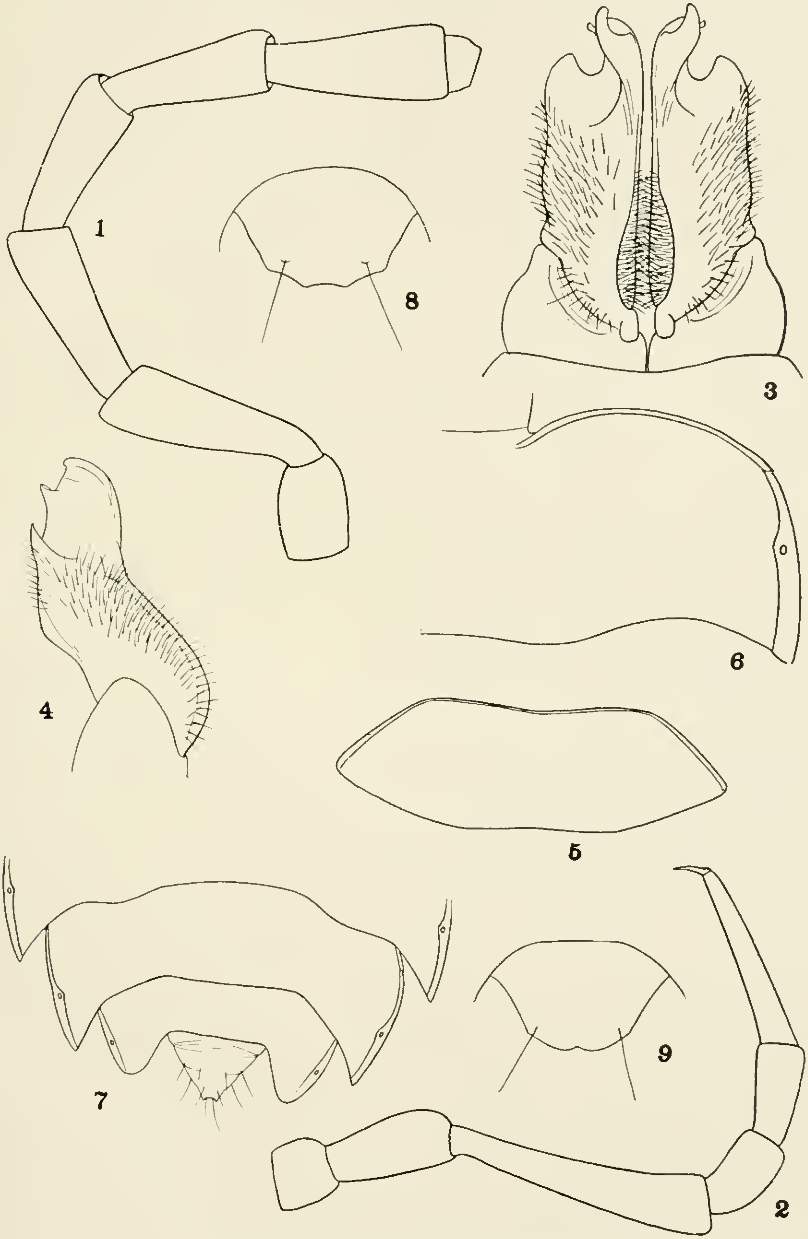

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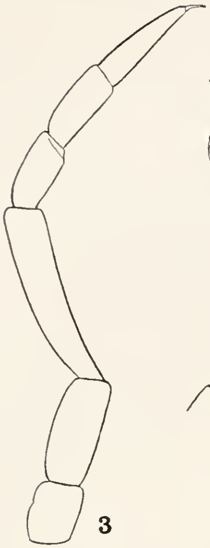
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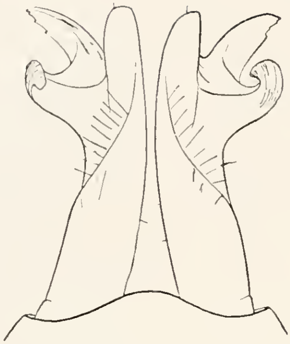
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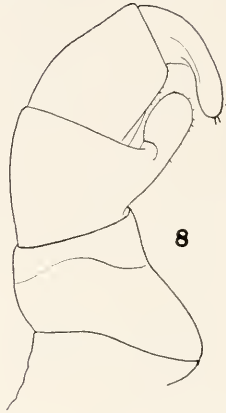
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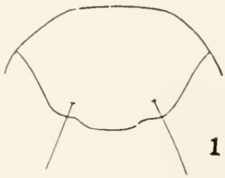
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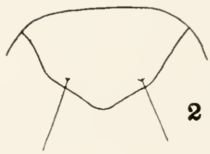
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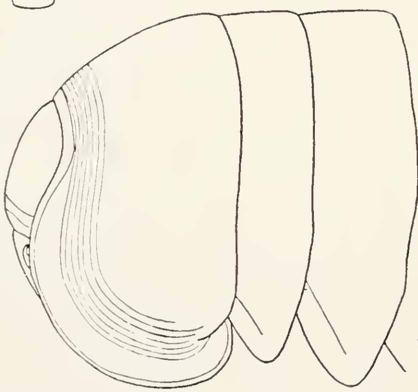
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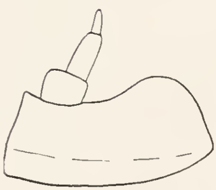
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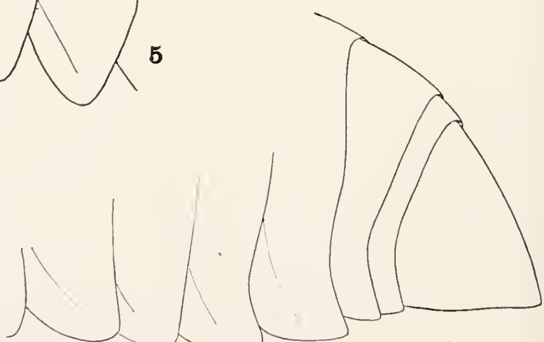
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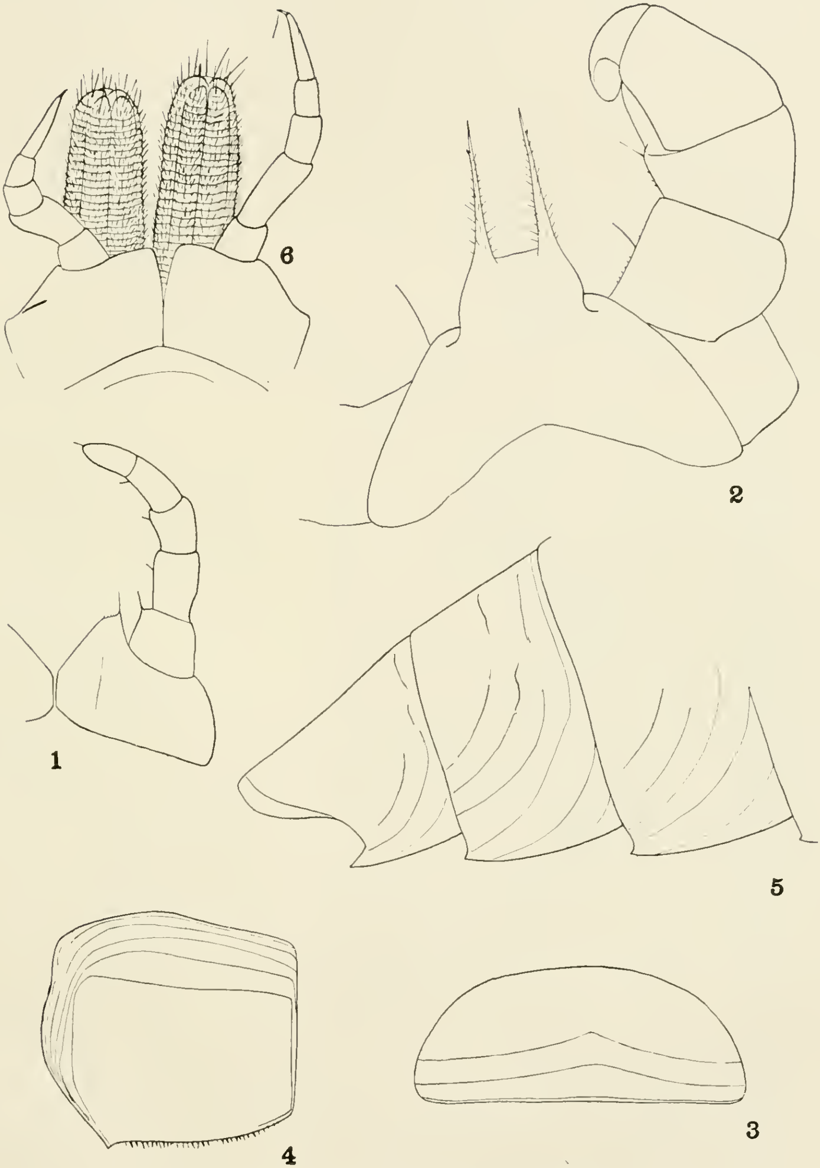


THE MILLIPEDS OF CENTRAL AMERICA.

FOR EXPLANATION OF PLATE SEE PAGE 71.

INDEX.

SYNOPTIC SERIES OF OBJECTS IN THE UNITED STATES NATIONAL MUSEUM ILLUSTRATING THE HISTORY OF INVENTIONS.

By Walter Hough,

Acting Head Curator of Anthropology, United States National Museum.

HISTORY.

Fifty years ago the United States National Museum was being rapidly and steadily enriched by a stream of ethnologic material poured in by explorations and expeditions carried on in the United States and in foreign lands. Among the first results of the classification of the collections was the recognition of similarities and differences in the material culture of races. This observation was to bear fruition in the exhibits of the Museum. There also arose at this period the germs of ideas as to the relative inventiveness of races, which is seen to have been a natural inquiry among a nation of inventors.

The study of certain common tools whose use extended among many different tribes was taken in due course. One of the early anthropological works published by the Smithsonian was Dr. Charles Rau's monograph on Prehistoric Fishing, which was a forerunner of numerous papers on the various industries of the American Indians. These publications form a large and important literature on aboriginal technology.

Such works also show that motivated by the earlier studies there arose in the analytic minds of Mason and Holmes conceptions of the distribution and sequence of inventions, and their relative grades, all of which gave an inkling of the progress of development by which series of objects could be arranged in order in historical categories from simple to complex.

While these studies were ripening almost unconsciously during the handling of the increasing materials coming into the Smithsonian no incentive to present these facts offered till, in preparing plans for the Trans-Mississippi Exposition held in Omaha, Nebraska, in 1898, it was suggested that a synoptic series illustrating the history of invention should be prepared for exhibit on that occasion.

The energies of the staff of anthropology were directed to this end and a series of extraordinary interest and value was prepared.

There is no evidence that this series attracted particular attention at the Omaha exposition or for some time thereafter. There began, however, an appreciation, slight at first, but rapidly increasing, concerning the educational value of this exhibit. The inconspicuous cases displaying the series came to be assiduously studied and were the object of special visits by classes from schools far and near. The cases taken to the Panama-Pacific Exposition at San Francisco in 1915 were placed on the curriculum of visits to the exposition by the schools of California, and it is estimated that 60,000 pupils inspected them.

The history of the various halting stages of development through which inventions have come to our hands from the past is of fascinating interest. It is only just that we who inherit should know our inheritance. This knowledge may not only prove an asset in expanding the mind but may be of economic usefulness in stimulating invention.

Every art that is used to minister to our comfort in this present vastly complex civilization has been brought forward step by step, beginning with the simple needs of cruder times. Some of these arts we may follow back into the oblivion in which they had their dawn, some branch off at later marks on the dial of progress, others arise in the full light of history, while myriads swarm within the memory of man.

The series deals with two classes of inventions—those whose ancestry is very ancient and which form the foundation stones of progress and those which begin with the present age of science and have part in its great material advancement.

Also some of the older inventions caught by the genius of the modern age have formed the starting points for new series, as the electric light, which has no genetic relationship with any of the lights which preceded it. The steam engine is also a similar example.

There are two arrangements of inventions practicable—the one followed in this paper, in which the order is by the grades of inventive results attained; the other is the distribution of inventions in area, demonstrating the effects of environment as shaping or modifying factors. Both are instructive and suggestive.

The specimens are arranged in the order of their grade of development irrespective of race, place, or time. The series therefore do not always represent a direct genesis of invention. They suggest rather the genesis and indicate how the mind of man has arrived at certain datum points which mark epochs in progress. No account has been taken of the fluctuations, the countercurrents, and eddies in the stream of invention, but only those specimens are selected which show a substantial improvement amounting to an advance.

In this paper 41 series are illustrated. The series are intended to lead the reader to the threshold of the inventive period which marks the present day. The modern inventions are thus beyond the scope of this paper and should be taken up in another publication.

The preparation of the series, with its accompanying literature, is the work of Prof. Otis T. Mason, Prof. W. H. Holmes, and the writer. Hastily gathered together in the press of exposition work, it was scarcely a finished product, and despite careful review and editing for publication no doubt inaccuracies will be found and, it is hoped, condoned.

It is confidently believed that the publication of this work will greatly extend its usefulness in the educational system of the United States through its stimulation of thought and especially by the simplicity of its teaching. The development of invention is like the unfolding of the human mind. It shows the connection of the present with the past and attains one of the chief objects of science, which is to reveal the structure of our civilization.

HISTORY OF FIRE MAKING AND ILLUMINATION.

At some early period man had a knowledge of fire in nature, derived from the volcano, from lightning, or from the friction of branches in the wind, but he made no more use of it than did the animals.

At a later period he began to use fire from some one of these sources, carefully preserving it. Later he discovered that by rubbing two sticks together fire could be produced at will, and by knocking together pieces of flint and pyrites sparks capable of igniting tinder could be had. In the iron age this became the familiar flint and steel, which gave way, after a number of chemical inventions, to matches. The use of fire also marks the beginning of artificial illumination, which has developed along the lines of the torch and the lamp. The beginnings of metallurgy, ceramics, and other arts that have reached a high degree of development in this century are found in this first use of fire.

SERIES 1.—FIRE MAKING.

Plates 1 and 2.

The illustrations of specimens in the United States National Museum show the implements used in making fire through friction of wood, percussion of minerals, compression of air, focusing of the sun's rays, through chemistry, and terminating with the electric lighter.

The series is preceded by three drawings, the first two illustrating presumptive sources in nature, namely, the volcano and lightning,

from which man may have obtained fire before he knew the manner of kindling it artificially. The third picture illustrates the primitive camp fire, where fire was preserved, and the conveying of fire from one camp to another.

The steps of man's acquaintance with fire are three—the knowledge of fire, the means of utilizing it, and the means of producing it. The last step, which is one of the most important in man's history, is illustrated fully in the series.

Improvements in the method of producing fire have followed the great steps of man's progress, and, besides, each method has been subject to various modifications by different peoples. To illustrate, the simple method of rubbing out fire from two sticks with the hands has been improved by adding the bow and socket and the weighted stick, as in the pump drill, and finally the machine with cog wheels and crank employed in the Soudan.

No. 1. Volcano in action; lava setting fire to forest (pl. 1, No. 1) ------ 178,157

No. 2. Lightning setting a forest on fire (pl. 1, No. 2) ---------------- 178,157

No. 3. Camp fire; man borrowing fire (pl. 1, No. 3) ------------------- 178,159

No. 4. Fire saw. Strip of bamboo drawn across a section of bamboo. Dyaks of Borneo and other Malays ---------------------------------- 178,152

No. 5. Fire thong. Rattan thong drawn over a grooved piece of wood. Dyaks of Borneo --- 178,152

No. 6. Fire plow. Blunt stick worked along a groove in a lower stick. Polynesians --- 178,152

No. 7. Fire drill. Slender rod twirled between the hands upon a lower stick having a cavity with slot. Indians of the United States and widely diffused in the world --- 176,353

No. 8. Fire drill. Rod held in a socket and gyrated by means of a cord. The lower piece of wood has a cavity with slot, opening upon a shelf. Eskimos of Alaska --- 127,644

No. 9. Fire drill. Rod held in a socket and gyrated with a bow and cord. Lower piece with cavities on a central groove. Eskimos of Alaska -- 48,078

No. 10. Fire drill. Pump drill used specially for sacred fire. Iroquois Indians, Canada.

No. 11. Strike-a-light. Flint and iron pyrites struck together as the ordinary flint and steel. Eskimos of Alaska ------------------------- 178,154

No. 12. Strike-a-light. Flint and steel and box for holding flint, steel, and tinder. Sulphur-tipped splint ignited from the tinder. England, 130,436

No. 13. Strike-a-light. Bamboo tube and striker of pottery used as flint and steel. Two boxes for tinder. Malay.

No. 14. Tinder pistol. Gunlock adapted for throwing sparks into tinder. England -- 175,712

No. 15. Strike-a-light. Combination of flint, steel, tinder, and extinguisher, for carrying in the pocket. Spain ---------------------------- 178,155

No. 16. Fire syringe. Cylinder with closely fitting piston bearing tinder. Driving the piston down smartly kindles the tinder. Siamese and Malays -- 176,091

No. 17. Lens. Used for prodncing fire by focusing sunlight upon tinder. Ancient Greeks -- 178,151

No. 18. Hydrogen lamp. Hydrogen gas is made to play upon spongy platinum, causing it to glow, Germany, 1824 165,440
No. 19. Match light box. Bottle of sulphuric acid, into which splints tipped with chlorate of potash and sugar were dipped. Vienna, 1809 151,711
No. 20. Matches. Various kinds of phosphorus matches 178,156
No. 21. Electric gas lighter. Cylinder containing a small dynamo run by pressure of the finger, producing sparks between the points at the upper end of the tube. United States, 1882 200,512

PRIMITIVE FIRE MAKING.

Plate 3.

California Indian making fire by friction.—California Indian man, dressed in native costume, in the act of procuring fire by means of the fire drill. The heat generated by the friction of the wood is communicated to the dust ground off during the operation, causing it to ignite. This process is, perhaps, the earliest method of procuring fire by artificial means. Hupa, Athabascan stock, California.

SERIES 2.—TORCH AND CANDLE.

Plate 4.

This series epitomizes the development of the candle, beginning with rolled leaves, the burning of the fat bodies of fishes or birds, and of faggots of resinous wood. Continuing, the series shows torches consisting of rudely aggregated slivers of wood or sheets of bark, torches of more careful manufacture, torches made of wax or resin inclosed in palm leaf, forming an exterior wick, torches of rope or cords soaked in wax or resin, the crude beginning of the candle, and follows through formed candles, dipped candles, and molded candles, terminating with the elegant art candles of the present day.

While the line of development has proceeded from the rude torch to the candle the steps marked by the specimens in the series are suggestive, embracing devices employed by many different peoples and at divers times. Following the torch in the line of development comes the lamp, which separates from the stem of the torch at a period when oils and fats came to be used. This may have occurred after the domestication of animals whose fat was available, at the time of the discovery of mineral oils, or of the utilization of vegetable oils, such as that of the olive and coconut.

The history of the lamp is shown in series 3.

No. 1. Folded palm leaf used as a torch. East Indies.
No. 2. Stormy petrel, burned in the Orkney Islands for light 178,160
No. 3. Candle fish in a split stick, burned for light. Alaska 178,161
No. 4. Torch made of birch bark. Iroquois Indians 178,162
No. 5. Torch made of splint fat-pine knots. Virginia 129,997

No. 6. Torch made of a bundle of slivers of fat pine. Southern Indians 178,163
No. 7. Torch made of damar gum wrapped in palm leaves. Malays 76,727
No. 8. Torch or "link" made by soaking rope in resin. Europe in the Middle Ages 178,164
No. 9. Torch composed of cords soaked in fat or wax. Europe, sixteenth century 178,165
Nos. 10 and 11. Cord soaked in fat or wax, coiled, for lighting. England. 178,166
No. 12. Rush soaked in grease, forming a primitive candle. England 178,167
No. 13. Stick smeared with grease for lighting. Mongolia 178,168
No. 14. Mass of fat formed upon a stick, around which is wound a wick of fiber. Kashmir, India 175,141
No. 15. Tallow dip with rush wick, later cotton. Northern Europe.
No. 16. Candles formed of wax; wick of fiber. Japan and North Africa. 128,246, 178,169
No. 17. Molded candles. Patent candles of stearine, paraffine, and wax, and decorated candles. Nineteenth century 178,171

SERIES 3.—LAMP.

Plates 5 and 6.

The development of the lamp has been an extremely slow process. In the centuries before Argand efforts for the improvement of the lamp were confined to multiplying the number of wicks or to selecting wicks of greater capillarity and to a less extent to the improvement of illuminants. In respect to the amount of light furnished, the Eskimo, through stress of geographical conditions, had invented a lamp superior to any in use by civilized nations up to three centuries ago.

Usages which seem to antedate the actual lamp are the customs of throwing oil or bits of inflammable material on the fire for temporary light, the use of fireflies, and the employment of the bodies of fat birds and fish, as shown in the beginning of the torch series.

The history of the lamp begins with crude objects taken from natural surroundings, such as hollow beach stones, shells, or bones, furnishing reservoirs for fats or oils. The structure of the lamps reflects the stages of the world's progress as to materials, having been successively stone, pottery, bronze, iron, and glass. There were also minor improvements in the reservoir, wick tubes, wicks, and quality of oil, as shown in the specimens.

With Argand came that important invention, the regulation of the supply of air to the wick, coupled with the employment of a chimney to increase draft.

Following this came a multitude of inventions included in the past 125 years, most of them taking their rise after the discovery of gas and petroleum, which supplied cheap and suitable illuminants.

Within 40 years the electric light has been perfected to the standard of the incandescent lamp and the incandescent arc lamp.

Gas has also shared in the progress, as displayed in the Welsbach incandescent gas burner.

Far from being superseded by these inventions, coal-oil lamps have kept pace with them in brilliancy and usefulness.

No. 1. Firefly lamp. Perforated tree gourd in which fireflies are confined for light. West Indies.
No. 2. Lamp made from the skull of a sheep ---- 178,186
No. 3. Lamp. Pecten shell with oil and wick of rush pith mounted on a forked branch. Ainos, Japan ---- 178,187
No. 4. Lamp. Unworked beach stone, with concavity, supplied with fiber wick and oil. Aleuts, Alaska ---- 13,017
No. 5. Lamp. Hollowed beach stone with moss wick arranged along one edge. Eskimos, Alaska ---- 16,900
No. 6. Lamp. Fusus shell suspended. Orkney Islands ---- 178,188
No. 7. Saucer lamp with shallow grooves for wick. India.
No. 8. Lamp. Terra-cotta saucer. India ---- 164,920
No. 9. Saucer lamp with pinched-up spout for wick. Ancient Syria.
No. 10. Stone lamp with pointed spout. Cashmere, India.
No. 11. Lamp of terra cotta. Reservoir almost closed over; spout for wick. Roman ---- 74,561
No. 12. Lamp of terra cotta. Reservoir closed over; spout for wick. Roman. 175,583
No. 13. Lamp of brass. Reservoir mounted on rod and stand; several spouts. Italian ---- 129,400
No. 14. Lamp. Designed to furnish oil to the wick under pressure. Cape Cod, Massachusetts. Colonial period ---- 151,483
No. 15. Lamp of glass having two tubes, for burning lard or whale oil. United States. Eighteenth and early nineteenth centuries ---- 130,610
No. 16. Lamp, with chimney, draft around the wick, and oil under pressure. Argand's invention. United States ---- 130,667
No. 17. Lamp. "Fluid" or camphene, burned by means of wick and tubes and without chimney. United States ---- 178,189
No. 18. Lamp, with chimney and Argand burner, oil under forced pressure of a spring. France ---- 130,669
No. 19. Lamp, with chimney; burner ventilated; tubular wick, raising refined petroleum by capillarity. United States, 1876 ---- 73,829
No. 20. Gas burner. United States ---- 178,190
No. 21. Electric arc lamp. (No cut.) The familiar arc lamp would appear here.
No. 22. Incandescent hood for gas burner. Welsbach's invention ---- 178,192
No. 23. Incandescent electric lamp ---- 178,191

SERIES 4.—COOKING UTENSILS.

Plate 7.

The history of cooking begins with the camp fire. At first the methods were confined to broiling and roasting by the direct application of heat, illustrated in the series by broiling sticks and the gridiron (Nos. 1 and 2). The next step is frying, illustrated by the two specimens embraced in No. 3.

Baking is illustrated by baking dishes and the primitive earth oven and the familiar form of portable oven (Nos. 4, 5, and 6).

Boiling, which is the third method, is illustrated by the basket and stones which were heated and used in "stone boiling" and pots for boiling and stewing and culminates in the double boiler and chafing dish (Nos. 7, 8, 9, 10, and 11).

Cooking by steam is illustrated by the double vessel called the steamer (No. 13).

The series is to be regarded only as an epitome of a subject capable of extensive elaboration and which it is expected to be taken up in extenso later.

No. 1. Broiling sticks. Stuck in the ashes of the fireplace. Fish are spitted on them for broiling. Ainos, Japan. Broiling fork of iron. Sioux Indians, Dakota ---- 150,963, 126,802

No. 2. Gridiron. Set over coals for broiling meat. Colonial period, United States ---- 127,284

No. 3. Frying pan of stone. Frying pan on small stove of earthenware. Korea and Portugal ---- 151,634, 178,193

No. 4. Baking dishes, of soapstone, heated and filled with acorn mush, which is baked by the heat of the stone and before the fire. Hupas, California ---- 77,170, 77,172

No. 5. Samoan pit oven. Alternate layers of food and hot stones are placed in pit, covered over, and allowed to bake.

No. 6. Oven. Iron vessel with short legs, handle, and heavy lid, for baking by means of hot coals placed on top and underneath. United States, 130,315

No. 7. Boiling basket. Food to be cooked is placed in the basket and heated stones are dropped in. The method is known as "stone boiling." Clallams, Washington ---- 23,512

No. 8. Coiled pot for boiling. Ancient vessel from the abandoned pueblos. Hopi, Arizona ---- 69,874

No. 9. Tripod pot for boiling. Earthenware, with three legs, allowing the vessel to be set up in the fire. Zuñi, New Mexico. This form was acquired from the white man's cooking pots, but stands for the type ---- 68,379

No. 10. Shoe-shaped pot. Earthenware, small handle. In use this vessel was thrust in the ashes at the side of the fire. Hopi, Arizona ---- 155,930

No. 11. Chafing dish. Combination stove for boiling and frying ---- 178,206

No. 12. Rice boiler. Double vessel, the lower containing hot water to prevent the food from scorching ---- 178,208

No. 13. Steamer. Double vessel, the bottom of the upper portion perforated and set over the lower vessel containing hot water. Used for steaming food ---- 178,207

HISTORY OF UTENSILS FOR PERSONAL USE.

SERIES 1.—KNIFE AND FORK.

Plate 8.

The knife and fork as eating utensils of personal use have developed together. This series shows the skewer-like fork and bamboo knife, combination knife and one-pronged fork, chopsticks and knife, combination of knife, fork, and spoon, and the modern table knives and forks.

Geographically, the ruder forks and knives are found in southeastern Asia and in the Pacific islands among peoples of a low state of culture. The Indians of the Americas are not known to have used forks of any kind, the fingers and spoons answering all purposes.

Among civilized nations the fork also developed from the skewer, and forks of two tines appeared very late, while forks of three or more tines are modern.

No. 1. Simple stick suggestive of the fork for eating marrow from a bone, South Dakota ---------- 151,494
No. 2. Bamboo knife and fork. (Model.) Andaman Islands.
No. 3. Combination knife and fork. (Model.) Andaman Islands.
No. 4. Chopsticks and knife. Japan and China---------- 175,299
No. 5. Knife and chopsticks in case. China---------- 169,151
No. 6. Combination fork and spoon, folding. Knife and spoon in one piece. Spain and Africa---------- 167,017, 167,464
No. 7. Fork and spoon in leather case. Switzerland---------- 175,246
No. 8. Knife and fork, old style. Germany---------- 175,244

SERIES 2.—SPOON.

Plate 9.

The history of the spoon begins with the introduction of methods of cooking food by boiling and stewing. The spoon has always been a utensil for conveying small portions of liquid food to the mouth, larger spoons for stirring being variations. The series suggesting the growth of the spoon begins with unmodified shells and rinds of gourds and passes through spoons showing the development of the handle to elaborately carved and ornamented specimens, closing with spoons of metal.

Although there has been a general development through successive steps of progress connecting the earliest and simplest forms of the spoon with the artistic productions of our higher civilization, the spoons employed at a given stage of culture have an extremely wide range of diversification, varying with environment. This series may serve, however, to show the full range of forms of this utensil and to suggest in a general way the course of development.

No. 1. Unmodified shells used for spoons. Mexico and California, 174,494, 131,163
No. 2. Modified shell and rind of gourd. New Guinea and British Guiana, 73,369, 45,669
No. 3. Spoons with projections designed for grasping. Tortoise shell and sea shell. Utah and Florida---------- 77,160, 14,475, 5,437
No. 4. Spoons with worked-out short handles. Shell and horn. Tennessee and Wyoming. Spoons with well-developed handles. Alaska, and Wyoming ---------- 165,912, 32,053, 56,011, 165,893
No. 5. Clamshell clamped in wooden handle. Alaska---------- 168, 368

No. 6. Spoon with elaborately carved handle of horn joined to bowl. Alaska, 88,907

No. 7. Spoon painted and decorated with geometric and conventional figures in black and red. Alaska ---- 37,119

No. 8. Spoons of metal. Bronze spoon, Rome; pewter spoon, England. Modern pewter spoon, England ---- 101, 164, 175, 296

SERIES 3.—CUP.

Plate 10.

The cup is older than the spoon and may well claim to be the most ancient utensil from its connection with water drinking. Theoretically, the partially closed hand and folded leaf are the most primitive cups. This series epitomizes the progress of drinking vessels and includes sea shells, cups made by bisecting hard rinds of fruit, and cups belonging to the class of tumblers. Cups with stable bases, cups with handles, cups of lacquer and metal, and cups of china complete the series.

The wide diffusion of cups in time and area renders it possible to select specimens which illustrate the effect of environment. Cups have been made of every conceivable material, and numerous natural forms have been adapted for the purpose.

The cup has also been made an expression of art and luxury from the most ancient times, and the most precious materials and cunning skill have been lavished on its manufacture.

No. 1. Shells used as drinking cups. Africa and Mexico ---- 174,733, 174,494

No. 2. Cups made by bisecting the coconut and tree gourd. Fiji Islands and South America ---- 164,775, 487

No. 3. Cups made of gourd and an imitative pottery form. South America and Arizona ---- 128,324

No. 4. Cups without foot or base for support. Tree knot and horn. New Mexico and Wyoming ---- 68,450, 165,895

No. 5. Basket cup. Apaches, Arizona.

No. 6. Cups having base or foot. Pottery and bamboo. China and India, 130,453, 130,341

No. 7. Cups and handles. Pottery and wood, decorated. New Mexico and Africa ---- 40,643

No. 8. Cups of lacquer, metal, and elaborately carved coconut with cover. Burma and China ---- 154,224, 176,651

SERIES 4.—TOBACCO PIPE.

Plate 11.

The pipe is a utensil for smoking tobacco or other plants and is later in point of invention than the cane cigarette or bundle of rolled leaves known as the cigar.

The first three numbers of the series show simple pipes, consisting of straight tubes of bone and wood, and curved pipes, in which

the stem and bowl are differentiated. The series proceeds through pipes with separate stems, ornamented and carved pipes, and terminates with the modern meerschaum.

It has been thought that the pipe was used for tobacco alone and that it was invented in the area where the tobacco originated. On the contrary, examples have been found in Europe which antedate those of America, and it must be concluded that the pipe was used in prehistoric times for smoking herbs other than tobacco, probably as a ceremony.

After the discovery of the New World the pipe, together with the use of tobacco, spread with wonderful rapidity over the whole earth.

No. 1. Pipes made of straight bone tubes, slightly worked. Comanche and Kiowa Indians — 6,901, 6,902

No. 2. Straight pipe of wood with stone bowl set in the end. California — 77,182

No. 3. Curved pipes of clay and stone, with stem differentiated. Virginia, England, Oregon, and Washington — 165,458, 129,692, 720, 1,984

No. 4. Pipes of stone, with bowl and stem separate. Pipe of catlinite inlaid with metal (platform type); mound bird pipe. Mound builders, North Carolina, and Plains Indians — 130,497, 131,326, 18,813

No. 5. Pipes with stem and bowl separate. Alaska, Labrador, and Japan — 89,289, 90,083, 4,035

No. 6. Pipe of pottery. Human figure, seated. Africa — 151,138

No. 7. Pipe of carved wood inlaid with abalone shell; mythological subjects. Alaska — 74,925, 74,924

No. 8. Meerschaum pipe, silver mounted, with cover. Germany — 130,652

HISTORY OF TOOLS.

This subject embraces the common hand tools which were used in the more primitive periods. They serve as extensions of the hand for definite purposes, and the motive power is the energy of human muscles. They consist of cutting tools, as the jackknife (series 1), the ax (series 2 and 3), the adz (series 4); pressure and abrading tools, as the hammer (series 1), the saw (series 2), the drill (series 3), and the scraper (series 4). These eight series represent tools which have had a profound effect on human history in its earlier phases. They have come down into this age and have been given vastly increased powers. They are still and will forever remain the indispensable agencies which articulate the hand of man with material nature.

SERIES 1.—JACKKNIFE.

Plate 12.

Among industrial tools of general use there is a class for cutting, commonly called "edge tools." These vary in structure, manner of working, and results, and have received different names, such as knives, chisels, axes, and so on.

The jackknife is a tool for whittling, for making chips or shavings in wood and like substances, and always works by pressure, never by a blow. The first jackknives were spalls of siliceous stone, little modified from natural forms, having one portion, the working part, sharp, the other portion, or manual part, after a fashion fitting the hand. The elaboration of the jackknife consists in the development of the blade, the handle, and the connective devices between them. The series ends with complicated forms for general use and differentiated forms in endless variety for special crafts. In the mechanical stage of industry the functions of the jackknife are performed with great celerity in planing mills. The plane itself is a jackknife working with a gauge. The objects exhibited in this series are suggestive of steps in the elaboration of the jackknife.

No. 1. Knife consisting of spall of stone ---- 173,563
No. 2. Knives consisting of spalls slightly modified ---- 30,504, 146,131
No. 3. Knife consisting of long flakes specially selected ---- 99,918
No. 4. Knife from long flake, chipped on the edge ---- 173,566
No. 5. Symmetrically chipped blades, the grip formed by wrapping one end with fur ---- 98,813, 26,230
No. 6. Chipped blades, with tang for attaching to the end of the handle ---- 17,319, 14,329, 63,769
No. 7. Chipped or ground blades of stone, with tang for side hafting ---- 48,826, 136,991
No. 8. Knives of bamboo, the hard exterior forming the cutting edge. West Borneo and Gaboon River, Africa ---- 249,048, 164,484
No. 9. Knife of ivory with slightly shaped handle. Knife of scapular bone with wrapped handle. Eskimos, Alaska ---- 26,040
No. 10. Clam shell with sharpened edge. Beaver tooth set in handle. Eskimos and Indians, Alaska ---- 36,366, 168,352
No. 11. Copper and bronze blades; handle and blade in one piece ---- 101,223, 101,405
No. 12. Metal blades, with tangs to be driven into the ends of handles.
No. 13. Metal blades, with sockets for handles ---- 147,420, 14,722
No. 14. Metal blades, with flat tangs for rivets ---- 101,338, 45,948
No. 15. Hinged blades, closing in the handle. Morocco ---- 130,324, 168,804
No. 16. Hinged blade, closing in the handle with a spring. American Frontier. 54,340
No. 17. Farrier's knife, with hinges and springs, showing a variety of blades.

SERIES 2.—EUROPEAN AX.

Plate 13.

The lowest form of the ax is a fragment of stone so sharp that, held in the hand, it can be used as a chopping tool. An important first step in human progress was the discovery of means for increasing the efficiency of this natural tool by sharpening its edge. For a long period this was accomplished by striking off flakes with another stone; later pecking and grinding were employed for this purpose, and handles were attached in various ways to give greater power to the stroke. It was a long time before metal came into use, and it is

only very recently that the invention of steel has furnished humanity with a satisfactory chopping tool. The most important function of the modern ax is the cutting of wood. The bronze ax took many forms in Europe, and in the series here presented these are followed by two stone axes which, on account of their method of hafting, are placed next the iron and steel tools.

In early days the ax was a weapon as well as an implement, and with simple peoples it still serves as a weapon. The machine ax, of which a model is presented in No. 16, is a comparatively simple contrivance when placed alongside of the marvelous machines that stand at the head of some of the other lines of mechanical progress.

No. 1. Stone ax or hatchet, earliest and simplest form of cutting implement known to have been made by man. Nodule of flint roughly flaked. France. Thennes ---------- 99,440

No. 2. Stone ax or hatchet of flint, shaped by chipping. Sweden---------- 137,521

No. 3. Stone ax or hatchet of flint, shaped by chipping and finished by grinding. Sweden ---------- 136,743

No. 4. Stone ax or hatchet of nonchippable material, pecked into form and then ground ---------- 15,868

No. 5. Stone ax or hatchet; nonchippable material, pecked into form; ground and polished; poll roughened for insertion in wooden handle. Switzerland---------- 100,614

No. 6. Stone ax or hatchet; serpentine; ground; fitted in staghorn socket for insertion in wooden handle. Switzerland---------- 100,554

No. 7. Bronze ax or hatchet; cast; flat blade pointed above for insertion in wooden handle. France ----------136,700

No. 8. Bronze ax or hatchet; cast; blade flat with raised edges, to be inserted in handle---------- 148,628

No. 9. Bronze ax or hatchet; cast; wings and stop to aid in fixing handle---------- 101,101

No. 10. Bronze ax or hatchet; cast; wide wings at sides and hood at upper end for attaching handle---------- 101.172

No. 11. Bronze ax or hatchet; cast; socketed for insertion of handle; ring at side to aid in fixing handle---------- 101,110

No. 12. Stone ax or hatchet, pecked into form and then ground; drilled for insertion of handle Sweden ---------- 101.046

No. 13. Stone ax or hatchet, pecked into form and ground; drilled for insertion of handle---------- 137,138

No. 14. Modern iron ax; curved poll; used for timbering. Fusan, Korea, 129,495

No. 15. Modern chopping ax; iron and steel; in common use in United States.

No. 16. Wood-splitting ax; operated by steam power.

SERIES 3.—ABORIGINAL AMERICAN AX.

Plate 14.

A comparison of the American with the European stone ax is instructive. In America the typical implement is the grooved ax, which has a development well indicated in the series here shown. With the grooved ax there is associated a closely related family of

tools, generally known as celts, and it is these that present the closest analogy with the ax or hatchet of Europe, shown in series 2.

The first step in the series is a sharp-edged stone which is suited for use in the hand. Next comes the notched ax, which is roughly indented at the sides to facilitate hafting. Following are several examples indicating progress in the method of hafting. The West Indian and South American forms differ widely from the North American; they lack the typical groove, besides presenting other varieties of haft attachment features. The perforation seen in Nos. 12 and 13, although observed in many parts of America, was not in general use.

The order of development is not derived from any one people or group of peoples, but in a general way corresponds, no doubt, with the course of progress on the Eastern continent.

The uses to which the ax and its associated tool, the celt, were devoted cover a wide range of activities.

No. 1. Stone ax made by splitting a flattish bowlder. Held in hand and used as a chopper. Seen in use among California Indians ____________ 139,793

No. 2. Stone ax made from oval water-worn bowlder; chipped from one side to a rude edge; held in the hand; possibly hafted. Virginia _______ 1,073

No. 3. Notched stone ax; fragment of rock chipped slightly on margins and notched for attachment of handle. Virginia _________________ 173,213

No. 4. Grooved stone ax; water-worn pebble of trap rock partially pecked or battered into shape and then ground to an edge; poll used as a hammer. Rhode Island ____ 17,639

No. 5. Grooved stone ax; porphyry; pecked into shape and then ground; encircling groove with bordering ridges. Massachusetts ___________ 6,542

No. 6. Ground stone ax; fine-grained stone; ground all over; flat back; groove bordering ridges. Ohio ____ 29,014

No.7. Grooved stone ax, two-edged; groove in middle, with bordering ridges; surface ground and part polished. Pennsylvania ________________ 2,352

No. 8. Grooved stone ax; blade nearly round; ground all over; groove near poll, encircling ridge above; pointed poll. Costa Rica _____________ 137,023

No. 9. Stone ax, squarish outline; polished all over, with notches in edges for attachment to handle; poll hollowed to fit handle above ________ 17,280

No. 10. Stone ax; semilunar blade, with tenon or stem for insertion in handle. Brazil ____ 27,003

No. 11. Copper ax with winged poll for attachment by cords to handle. Cuzco, Peru ____ 195,554

No. 12. Stone ax; water-worn pebble pecked and ground to edge; hole drilled through center flatwise; poll squared and ground lengthwise for attachment of handle by cords. Bolivia ______________________ 27,087

No. 13. Copper ax, chopping-knife form; stem or poll perforated for attachment of handle. Peru ____ 146,073

SERIES 4.—ADZ.

Plate 15.

The adz had its beginnings in the same forms and the same group of activities as the ax, the celt, and the scraper. Its differentiation

took place no doubt when the shaping of wood became an important feature in the savage economy. In the most primitive forms the stone blade is flaked into shape (No. 1), and in the more highly developed (Nos. 4 and 5) it is pecked and ground, the distinguishing characteristic of the implement being the single bevel of the edge. The hafting is accomplished in a variety of ways. One of the highest forms of the simple tool is the steel hand adz of the present period (No. 12). This implement may be regarded as the prototype of the modern planing machine, which is a compound adz, several blades being mounted on a revolving shaft. A model of this device appears in No. 13, which is the working part of the superb machines of to-day.

No. 1. Blade of flint, reduced to a beveled edge by flaking. Simpler forms are sharp stones identical with the earliest axes. Virginia........ 1,073
No. 2. Adz made of column of conch shell by grinding an edge, mainly from one side. Simple style of hafting. Florida........ 3,687
No. 3. Adz made of diorite flaked into shape and sharpened by grinding. Primitive hafting. Samoa........ 19,342
No. 4. Stone adz, pecked and ground into shape; wooden handle attached with twigs. British Columbia........ 88,720
No. 5. Polished stone adz, neatly fixed to an effective wooden handle. New Guinea........ 73,355
No. 6. Stone adz, with hollowed blade, curved edge, and shell adz, showing origin of this form. Rhode Island and West Indies........ 17,687, 747
No. 7. Copper adz blade, shaped by hammering; well specialized form; curved edge. New York........ 18,960
No. 8. Copper adz blade, shaped by hammering; socket for handle, made by incurving margins. Wisconsin........ 32,615
No. 9. Iron blade fixed on primitive handle by means of buckskin thong. Indians of Washington........ 130,983
No. 10. Iron blade of modern type, with highly specialized handhold attached by leather strap. Indians of Washington........ 74,770
No. 11. Small, rudely hafted adz; blade and method of hafting advanced shape. Ceylon........ 168,684
No. 12. Common steel adz for use in one hand; highly specialized shape. United States.
No. 13. Cutter head of modern planing machine. May be regarded as a compound adz.

SERIES 1.—HAMMER.

Plate 16.

The hammer has been from the beginning an important factor in human progress. The earliest known forms are round stones, which were employed in various useful arts, for shaping implements, in war, and in the chase. Identical forms are used by such living tribes as still occupy the first few rounds of the ladder of culture.

As the pioneers of civilization advanced step by step to higher levels the hammer was modified and improved. The simple rounded stone gave way to the specially shaped stone, and then the art of hafting

was devised, which conferred on the user vastly augmented power. The implement was notched, grooved, or perforated to aid in fixing the handle. Later on stone was supplemented by metal. Copper, bronze, iron, and steel followed in order.

The triumphs of human effort and ingenuity may be realized by comparing the stone hammer, still in use by half the race, with the machine hammer of to-day, illustrated in No. 14.

In very early times with our own race the hammer served as a weapon, and it still serves as such with most primitive people. In civilization this office is taken by more highly perfected devices, but vast expanse of function has taken place in our modern industries.

No. 1. Hammerstones. Natural pebbles of quartzite, modified by use in shaping stone implements. New Mexico and Ohio____________ 98,343, 130,554
No. 2. Hammerstones. Nodules of flint worn round by use. The usual stone-shaping hammer in Europe and America. Switzerland_ 100,561, 98,342
No. 3. Hammerstones. Natural forms battered around the periphery, with depressions in the sides. New York and Arizona_________ 6,602, 133,590
No. 4. Grooved hammers, slightly grooved for attachment of withe handle. Lake Superior____ ———, 2,334
No. 5. Grooved hammers, deeply grooved for mounting. Arizona.
No. 6. Stone hammer; rude granite; marks of use on face; ivory handle attaching by lashing of sinews. Eskimo________________________ 89,655
No. 7. Stone hammer; bowlder modified by use; slightly grooved; withe handle covered with buckskin. Great Plains________________________ 152,312
No. 8. Ivory hammer with modern handle, notched or grained in and fastened with cord.
No. 9. Hammers, one of staghorn, one of stone; drilled for insertion of handles. Swiss Lake. Yverdon________________________________ 100,634, 100,708
No. 10. Stone hammers, pecked and ground; drilled for handles; hammer face and ax or hatchet edge. Denmark and Prussia_______ 58,552, 137,134
No. 11. Old-fashioned claw hammer of iron, square face. Finland____ 167,876
No. 12. Modern blacksmith's hammer; cast steel; round face and peen.
No. 13. Modern claw hammer; cast steel; round face.
No. 14. Modern machine hammer.

SERIES 2.—SAW.

Plate 17.

The saw is a tool for severing materials by abrasion and cutting. The most primitive form of the saw is a siliceous stone having a ragged edge. Such an implement would be of great service to the savage in his working in wood, bone, horn, antler, ivory, and stone. The series passes through forms in stone, in sand cutting, and in metal, and finds its climax in the saw with composite edge in the sawmill, and in the refinement and specialization of the working part of the implement for various kinds of cutting. The prehistoric peoples of Europe as well as of America used stone saws for wood and bone. They were chipped flint, resembling knife blades, three or more inches long and serrated on one edge. As the objects cut did

not exceed an inch or two in diameter, these were ample for their needs. The Eskimos made their harpoon heads of hard serpentine and jadeite and by means of sand and slate were able to sever blocks of these stones 8 inches wide and 2 inches thick. The discovery of copper greatly added to the effectiveness of the implement, this metal being an excellent carrier of sand. The use of steel and of diamond edges and the perfecting of the teeth bring the saw to its latest effective forms.

No. 1. Flake, with rough edges, one portion better fitted for the hand. 100,591

No. 2. Flakes specially made for saws, chipped. 100,471, 173,568

No. 3. Spearhead specially modified for saw. 171,454

No. 4. Flint saw, one edge specially chipped, the other curved to fit in a handle. 100,965

No. 5. Sand saw; cutting done by means of wet or dry sand carried by wood or soft stone. 13,120

No. 6. Saw of soft metal to carry emery, corundum, or hard cutting material, 55,945

No. 7. Steel saw blade with irregular teeth; handle variously attached. 2,318

No. 8. Steel saw; serrate teeth; with or without backing. 120,501

No. 9. Steel saw with serrate teeth; set. 128,154

No. 10. Japanese saw with reversed teeth. 128,151

No. 11. Modern panel saw of steel; skewback; handle of wood to fit the hand; teeth set. Gift of Henry Disston and Sons.

No. 12. Crosscut saw for one man, with separate handles for each hand; teeth dentate, not set. (Model.) Gift of Henry Disston and Sons.

No. 13. Crosscut saw for two men; teeth dentate; back and front curved outward. (Model.) Gift of Henry Disston and Sons.

No. 14. Circular saw and band saw. Both have serrate teeth and are designed to have continuous motion, the one revolving on an axle, the other working over two drums. Gift of Henry Disston and Sons.

No. 15. Sections of crosscut saws: (1) teeth, three-fourths of an inch apart; (2) Humboldt pattern, with two cutting and one double-pointed scraping teeth; (3) "fleam tooth" with double cutting points, perforated. Gift of Henry Disston and Sons.

SERIES 3.—DRILL.

Plate 18.

A drill is a tool for making a hole. When acting in soft materials it plays the part of an awl or needle and is then moved by pressure. In hard substances drills of a class acted upon by hammers give rise to tools called punches. Drills of a third class, shown in this exhibit, act through circular friction, either by continuous or by reciprocating motion. This class becomes, according to the actions and sizes and the nature of their working parts, brad awls, gimlets, drills, augers, and so on. The most primitive form of the drill is a natural object with a hard point. Among savage peoples drills of hard stone are made by flaking one portion to a point and leaving the other for a hand hold. Stone drill points are followed by those of metal, which

are pointed, chisel-edged, tubular, screw-shaped, or bladed, as in the latest forms. The manual part of the drill is at first a mere adaptation to the hand of a portion of the tool. This is followed by crude handles, spindle shafts, strap drills, pump drills, and so on, up to the machine drills of our factories.

The Eskimos have three styles of apparatus for drilling—the hand drill, the strap drill, and the bow drill. The strap drill, as a rule, requires the services of two men, while the bow drill may be operated by one man, using also the mouthpiece for a pivot at the upper end of the shaft. The driller kneels or sits upon the ground and holds the object to be bored in his left hand. The working end of the shaft pierces this object, while the upper end is pointed and operated in a stone or other hard socket set into the wooden mouthpiece, which is grasped firmly by the teeth. With his right hand he revolves the shaft by means of a bow and cord.

No. 1. Cores of flakable stone, pointed for drilling. The grip may be finished with pitch or wrapping ---------- 23,659, 18,302

No. 2. Chipped drills with slender bits and flattened or crutch-shape grip. This flattened portion could be inserted in a "saw cut" at the end of a handle ---------- 32,526, 13,721, 173,790, 19.500

No. 3. Drill bits of stone and metal, the last named driven into the end of a piece of antler with crutch-shape grip ---------- 181,655, 89,973

No. 4. Drill bits of copper; useful in boring soft material without sand and hard material with sand. Method of hafting not known ---------- 147,334, 147,345, 147,309 (2)

No. 5. Spindle drill. Bit of iron or stone. The shaft is held between the palms of the hands and driven by reciprocating motion or worked on the naked thigh with one hand ---------- 128,751

No. 6. Strap drill, consisting of spindle and bit, mouthpiece and socket, and driving strap of rawhide, wrapped once about the spindle and driven by the two hands holding of grips of bear's teeth at the ends ---------- 33,654

No. 7. Bow drill. Spindle of wood, bit of iron, bow from seal's rib, mouthpiece of wood with stone socket. Reciprocating circular motion is produced by the backward and forward motion of the bowstring ---------- 177,734

No. 8. Pump drill. (Model.) Its parts are spindle and stone bit, spindle whorl, horizontal grip pierced by the spindle, and string of buckskin for driving. Reciprocating motion is given by the vertical movement of the grip ---------- 134,168

No. 9. Finland auger, consisting of bit inserted in the end of the stock; handle fitted in a mortise through the stock; socket of wood to fit against the breast, bolted to the upper end of stock ---------- 167,785

No. 10. Drill bits made from hardened steel, for boring steel and iron.

No. 11. Steel bits for boring in wood and similar materials. In China and Japan such bits were worked in straight handles.

No. 12. Steel center bit with gauge to regulate the size of the hole.

No. 13. Common brace and center bit for boring. These braces have fixed connective joints, and bits all have the same size butt.

No. 14. Brace with adjustable connective to fit the top of the bit.

No. 15. Mechanical drill. Spindle a screw with long thread, pivoted in a fixed handle above, moved by a nut of wood forced up and down the spindle.

PRIMITIVE SKIN DRESSING.

Plate 19.

Sioux Indian women dressing hides.—The Indians of the Great Plains were excellent skin dressers. Two classes of operations were employed; one pertained to the dressing of robes and the other to the tawing of hides. In the first operation the hair was not removed, but in the case of the larger animals the inner part of the skin was split off, so as to render the hides soft and pliable. By the other operation the skin, after being sweated, was depilated by means of scrapers of bone.

The Sioux Indian woman here shown is engaged in thinning a hide with an iron-tipped scraping tool after the preliminary process of unhairing has been completed.

SERIES 4.—SCRAPER.

Plate 20.

The scraper is a tool with an edge for abrading by pressure and friction. A knife, a piece of glass, or any edged tool may become a scraper if dragged over a proper surface at a proper angle. Stone or shells are primitive scrapers; they undergo modifications of form to suit the materials scraped, whether they be hides and other soft substances or harder materials, as wood, horn, bone, or ivory. The primeval mechanic employed scraping processes extensively in his work. The Eskimos scrape ivory and antler into shape with flint stones chipped to an edge. The Pacific coast tribes remove the superfluous wood, in excavating canoes and dishes, with scrapers. Savage women rely on the scraper to reduce the thickness of hides. Simple forms of the scraper are still employed, but are made of steel, by butchers, cabinetmakers, and other craftsmen for precisely the function it had in the beginning. The scraper has not, in the progress of industry, become to any extent a machine tool.

No. 1. Scrapers; spalls of hard stone with natural edges______________ 99,610
No. 2. Spalls of hard stone with chipped edges for scraping____ 99,310, 10,910
No. 3. Chipped scrapers with steep edges, specialized; notched for hafting, 146,229, 99,311
No. 4. Chisel-edge scrapers of fine-grained material. If worked with a blow and not by friction these become adz blades___________ 36,290, 127,719
No. 5. Eskimo scrapers set in grips of wood or ivory that fit the hand, 63,847, 63,852, 24,361
No. 6. Chipped scraper fitting in handle of antler, working like an adz.
No. 7. Chisel-edge scraper of fine-grained stone fitted into the end of a curved handle. Pits at the manual end to fit the fingers_____________ 43,927
No. 8. Scraper with iron blade, toothed slightly to render more efficient in special work of hide dressing__________________________________ 89,926
No. 9. Currier's tools for scraping and scouring hides________________ 104,688

No. 10. Scraper used largely by merchants in erasing marks from packing boxes.

No. 11. Scraper in use among greengrocers and butchers to clean their blocks.

HISTORY OF HAND WEAPONS WITH BLADES.

Omitting the employment of fire, smoke, poison, etc., to destroy life, the weapons of mankind are of three kinds—pointed weapons to pierce some vital part; edged weapons to cut the muscular tissues and even to chop the bony structure; and striking weapons to stun, to bruise, and to break the bones.

They are (1) held in the hand; (2) attached to the end of a shaft; (3) hurled from the hand, as a javelin; (4) shot from a bow, arbalest, catapult, or gun, or (5) thrown from a sling, throwing stick, or balista.

Natural objects, slightly modified, were the first cutting or slashing weapons. In one area they were shark's teeth fastened on a handle; in another silicious stones, used singly or on shafts, did the murderous work. Weapons of this class, however, were crude until the age of metals, when they assumed the first rank.

In the two series here exhibited hand weapons for piercing and cutting are shown. The first sets forth the development of the dagger, the second that of the saber and the sword. The two series run into each other so that there are no sharp lines of demarcation.

SERIES 1.—HAND WEAPONS FOR PIERCING OR STABBING.

Plate 21.

Daggers undergo various modifications, according to the grade of culture, the materials at hand, and the taste or idiosyncrasies of peoples. The series here shown is suggestive of the steps of progress in hand weapons for piercing. The first forms were pointed spines of vegetal or animal substances, either in their natural state or ground to a point. Metal weapons of this class for merely piercing are scarce. The function of cutting as well is easily added by making the blade triangular and sharpening the sides. The effect is then to pierce a vital organ or to sever a blood vessel. The bayonet is the modern expression of the hand weapon for piercing added to a musket or rifle.

No. 1. Fragments of flinty stone slightly sharpened at one end to form a point ---------- 100,257

No. 2. Prongs of antlers, one end sharpened, the other serving for a grip, 99,568, 137,208

No. 3. Split thigh bones ground to a point at one end, the other serving for a grip ---------- 58,241, 167,760

No. 4. Pointed bone and antler, with grip cut out into forms ------ 156,624, 19,269

No. 5. Long blades of chipped stone pointed at one end ---------- 20,419

No. 6. Chipped blades, hastate in outline, with blade and grip in one piece, but distinctly outlined -- 58,485, 32,831
No. 7. Blades of chipped stone, chipped glass, and iron set in the ends of spindle-shaped handles ------------------------ 168,563, 131,220, 16,361
No. 8. Leaf-shaped blades of chipped stone and metal set in grips of wood and covered with pitch or hide ------------------------------ 5,532, 126,527
No. 9. Copper blades, lanceolate, with tangs for hafting -------- 191,587, 149,722
No. 10. Bronze blades with socket or flat tang for hafting -------------- 101,347
No. 11. Double dagger of copper from Sitka, Alaska. Lanceolate blade, plain on one side, fluted on the other; constricted to form the grip; butt end pentagonal and ornamented with the design of a human face --- 89,020
No. 12. African curved knife with crescent-shaped blade, pointed, and having angular offsets from the edges near the base; tang drawn into the hilt. Serves for slashing, cutting, picking, and throwing ------ 174,899
No. 13. Bagdad dagger saber with curved blade; ribbed along the middle on each face; tang driven into the hilt, which is a flat ellipse in section cut out to form the grip ------------------------------------ 151,829
No. 14. Malay krises, one with straight, one with flame-shaped blade; hilt carved to fit the hand ------------------------------ 153,339, 153,341
No. 15. Catalan hinged dagger. Razor-shaped blade; hinge furnished with spring and with ratchet to set the blade at several angles; handle, of double design, adorned with brass and mother-of-pearl -- 151,161

SERIES 2.—WEAPONS FOR CUTTING AND THRUSTING.

Plate 22.

Cut-and-thrust weapons, with hilts, form the class, including sabers, swords, rapiers, claymores, and their congeners. When fastened to the end of a shaft or handle, they are halberts or Japanese long swords; when thrown from the hand, they branch out into the large class of African trumbases and throwing irons. The cut-and-thrust series here shown begins with a natural object, pointed and capable of slashing, and proceeds along the road of progress in ways suggested in this exhibit. The saber has but one edge, the back being thick and strong. The sword is the perfection of this type of weapons, having two edges and a point. The saber cuts flesh and blood vessels, and in its modern form with its dull edge also makes ugly bruises, and so comes into the category of bruising weapons. The sword is for piercing, cutting, and even for breaking bones, and in its largest form is used with both hands. Burton regards it as the most exalted weapon in single combats.

No. 1. Flakes of obsidian and flint suitable for slashing. Mexico- 35,159, 149,866
No. 2. Beautifully chipped blade, both edges sharpened and both ends pointed. Kentucky. May have had fur wrapped around one end to form a grip -- 2,407
No. 3. Sharks'-teeth slashing weapon, in which a wooden blade has sharks' teeth sewed close together on both edges. Gilbert Islands. Coconut-fiber armor coexists with weapons of this class --- 3,697, 178,064

No. 4. Copper blades for slashing, with grip, tang, or socket for hafting. Illinois, Greece, and Italy ---------- 7,535

No. 5. Boarding blade turned into a slashing weapon by wrapping the tang with split spruce root. Eskimos, Mackenzie River ---------- 2,077

No. 6. Slashing weapon, Malay blade, razor-shaped; tang driven into the end of the hilt. The latter is octagonal in section at the butt, curved, tapering forward, and ornamented with hair and basket work in bamboo ---------- 154,130

No. 7. Nepaul sword (*kookri*) with curved, leaf-shaped blade, thick on the back and chisel-edged; hilt of wood, fitting close to the blade, which has a shoulder on the tang; sword breaker on the blade near the tang. India ---------- 126,691

No. 8. Cutlass or machete. Blade of steel, thin, wide, curved at the end, double grooved at the back; tang flat, riveted between two pieces of carved wood to form the grip ---------- 151,162

No. 9. Japanese saber with nearly straight blade, pentagonal in section; grip of wood, with brass cap and ferrule and ornamented with knotted leather thong; guard against thrust.

No. 10. Cutlass. Straight two-edged blade; brass hilt, with guard. American Navy.

No. 11. Bronze sword. Blade long, leaf-shaped, and grooved, inserted into hilt piece and riveted; grip ridged; pommel adorned with open work. Roman.

No. 12. Gaboon sword, West Central Africa. Blade short, leaf-shaped, slightly ribbed, finely chased, and punched at inner end. This portion is furnished with sword-breaking attachment. Hilt elaborately adorned with wirework ---------- 164,912

No. 13. Chinese sword. Blade tapering slightly, point angular, shoulder of chased brass, covering the end of the scabbard; grip of bone, fluted; pommel of chased brass, with figure of Good Fortune ---------- 167,002

HISTORY OF PIERCING PROJECTILE WEAPONS.

Piercing weapons are either held in the hand or attached to a shaft. They are thrown from the hand, slung from the throwing stick, or moved by elasticity. Those moved by elasticity may be discharged from a blowtube, from a bow, from an arbalest, or from a firearm. The progress of invention in the piercing projectile is marked in the perfecting, firstly, of the projectile itself; secondly, of the elastic device or projector; and, thirdly, of the mechanism of release. Illustrations of the projectile are not shown. The series presented here serves to illustrate the progress of the bow and the arbalest, bringing the development to the gun and the pistol.

SERIES 5.—BOW AND ARBALEST.

Plate 23.

The bow is an elastic rod or stave which is bent, the two ends being united by a tough string. A bolt is shot from this apparatus, either to pierce, to cut, or to bruise. The first bows were unmodified staves;

the latest were made up of several pieces of different kinds of wood glued together and lined on the back with sinew or tough rawhide. The inner layer supplies the element of rigidity; the outer layer or back that of elasticity, and these two layers are held firmly in place by side pieces glued on. The limit of the simple bow is that of the muscular effort required to bend it; but if the bow be fastened to a stick, as in the bow gun or arbalest, then mechanical devices can be used to bend it, so that its rigidity and efficiency may be increased immensely; in fact, the different types of arbalest receive their names from the methods of bending the bow. There were three distinct varieties of this weapon—the *arbalete à pied-de-biche*, or hind's foot; the *arbalete à tour*, or rack-and-pinion crossbow, or great-stirrup crossbow; and the *arbalete à cry ro à cric*—lever crossbow in English.

No. 1. Zuñi bow. Plain sapling split and little modified; string of sinew cord. The Zuñi arrows are poorly made 69,574

No. 2. Sioux bow of hardwood. In this example is illustrated the double curve produced by heating and bending 1,769

No. 3. Yew bow of Oregon, overlaid on the back with sinew mixed with glue; grips covered with buckskin; nocks ornamented with fur; string of sinew.

No. 4. Eskimo sinew-backed bow of brittle wood, strengthened by ingenious wrappings of sinew cord, which is also laid in a cable along the back. The peculiar curve is that of the northern Asiatic bow.

No. 5. Compound bow of the eastern Eskimo, of three pieces of whale's rib, forming the grip and the wings. These are united with seizings of sinew thread and rivets, and the whole strengthened by sinew backing 19,513

No. 6. Crossbow from northern Labrador. Probably a toy, but illustrating a very primitive type of this weapon. Stock of pine wood; bowstring of sinew 73,017

No. 7. Chinese magazine crossbow. Darts are placed in a magazine having two slots and are discharged in pairs. The magazine is tilted, with the lever letting off the string.

HISTORY OF FISHING.

The art of capturing animals for food and other purposes has required a vast amount of tools and appliances. Herein the mind of man is pitted against the natural instincts of self-preservation, which animals have in a high degree. The result is an advanced order of inventions. From these the series relating to fishing has been selected.

The term fishing applies to the capture of animals living in the water. The apparatus used may be divided into two general classes—that by which the animal is taken involuntarily and that in which it effects self-capture or destruction. Those of the first class are usually called fishing implements, those of the latter traps. The

most primitive method of fishing is hand capture. Clubs for striking, nets and weirs for entangling, and poison for asphyxiating are all found among the instruments employed in this art; but the pointed implement is most common and has had varied differentiation. In this exhibit are shown four illustrative series—harpoon barbs, harpoon toggles, fishhooks, and sinkers. In the progress of invention the classes become intermingled. The first hooks or spears were very simple affairs. Aquatic animals, useful to men, were abundant and unwary. The increase of demand through enlargement of population rendered the animals more difficult to take, and the natural tendency of all peoples to accomplish the same end with less effort tended toward the improvement of the hook and the spear. So the efficiency of the hook, the length of the line, and the complication of the barb and the toggle have been modified and improved as culture advanced.

SERIES 1.—HARPOON BARB.

Plate 24.

The barbed harpoon (series 1) retrieves the animal by hooking into its skin or flesh. Its parts are the shaft or manual portion, and the head or working portion. In some examples the tang of the head is driven into the end of the shaft, in which case the implement is generally termed a spear; in other cases the butt end fits loosely into the shaft, so as to be easily withdrawn; it is then a harpoon. A short piece of line or rawhide is tied around a knob or through a hole in the head, and at the other end is fastened to the shaft. When the animal is struck the barb becomes hooked under the skin of the game, whose motions withdraw the head from the shaft, so that it is not broken. The line enables the hunter to retrieve. This type of apparatus begins with a natural object, which may have spines upon it, and passes through a refinement of the various portions of the structure in adapting it to animals of different sizes and habits. In fresh water the retriever is little more than a hand device for seizing, but among the Polynesians the handles to barbed spears used in sea fishing are 20 feet long. The Fuegians use a barbed head on a shaft quite as long, and the two parts are united by means of a short line.

No. 1. Bone head for small barbed harpoon; barb cut on one side. Heads of this kind are driven into the end of a shaft 100,533

No. 2. Patagonian harpoon head with one large barb. This head fits loosely into the end of a long shaft and is attached by a short line 131,217

No. 3. Patagonian harpoon head with 21 barbs, all on one side. Fits loosely in the end of the shaft 131,219

No. 4. Patagonian harpoon heads, arrow-shaped; tang fitting in a socket at the end of the shaft; attached to the shaft by short line 131,218, 129,488

No. 5. Ancient harpoon heads from French caves in form of arrowheads with many barbs; made to fit loosely in the end of the shaft; short connecting line tied in a hole or around the tang ---------------- 100,530, 8,145

No. 6. Ancient Peruvian harpoon heads, each having a bone shank and barbs of hardwood seized on near the point. The butt fits in a socket, and the head is attached to a line ---------------------------------- 176,795 (3)

No. 7. Ancient Peruvian harpoon head in three parts; arrow-shaped blade of quartz inserted and wrapped with cotton thread; barb of bone wrapped on the shank; shank of wood, with butt terminating in a cone to be inserted in the shaft ------------------------------ 176,796

No. 8. Kodiak harpoon head, Alaska. Head of chert, set in a shank of bone and wrapped with sinew thread; shank winged and round on the back; barbs three, made by saw cuts in the wing, butt tapering to fit in a socket -- 73,292

No. 9. Harpoon head from Mackenzie River, similar to No. 8, except that through trade with whalers and the Hudson Bay Company an iron blade, riveted, replaces one of stone ------------------------------ 7,420

No. 10. Harpoon heads of native copper and iron in one piece, from Sitka, Alaska. The barbs are all on one side --------------------------- 6,564

No. 11. Harpoon head of iron, from the Haida Indians, of Queen Charlotte Islands. Blade, barbs, and shank all in one piece; barbs alternating on the two sides of the shank; tang flattened and rounded for insertion; line braided from sinew ------------------------------------ 88,927

No. 12. Barbed seal harpoon from Norton Sound, Alaska, showing the barbed head, the foreshaft and its attachment to the shaft, the martingale or leader fastening the head to the shaft after the former is detached --- 33,944

No. 13. Shell-point barbed whale harpoon with leader. Makah Indians, Vancouver Island, British Columbia --------------------------- ———

No. 14. Gaff hook from China with harpoon point and single barb, socketed to be fixed on a shaft ------------------------------------- ———

No. 15. Barbed harpoon head or lily iron, of brass, for swordfish; barbs hinged to close in entering the fish and open for retrieving; butt socketed; becket rove through line hole ---------------------------------- 103,037

SERIES 2.—TOGGLE HARPOONS.

Plate 25.

The toggle harpoon is a piercing retrieving weapon driven into the animal by means of a shaft. The toggle is attached to the end of a line, and when the shaft is withdrawn it turns crosswise in the body of the game, enabling the hunter to retrieve. In the simplest forms a pointed bone serves for a toggle, but in the whaling harpoons much ingenuity has been exercised in perfecting the various parts, namely, the blade, the hinge, the barb, the socket, the line, the loose shaft, and the shaft. In some examples poison and explosives are used. There is a form of toggle used in catching water birds, fish, and crocodiles which is baited, and thus becomes a fishhook or gorge. The Aleuts shoot the sea otter with a delicate arrow which has all the parts of the toggle harpoon, and thus becomes a toggle arrow. For the smaller

seal the Eskimos of Norton Sound employ a very light harpoon, which is a model of delicacy and effectiveness. It is lanced from a spear thrower. In the same and in adjoining regions the large whale toggle is found of the same pattern, but clumsy looking, and it is used in the hand as well as lanced from a spear thrower. In the neighborhood of Point Barrow a seal is shot with a rifle from the edge of the ice and then retrieved by hurling a toggle harpoon at it in order to get a hold.

No. 1. Toggle harpoon of Shasta Indians. Toggle, a bone 3 inches long, pointed at one end, socketed at the other, and attached in the middle to a cord of hemp covered with a coating of pitch. California ---------- 76,199

No. 2. Toggle harpoons of the Hupas, in three parts; points of bone or iron; double bone barbs; rawhide leader; held together by a wrapping of twine covered with pitch; socket for the shaft between the barbs; line of hemp. California ---------- 126,525

No. 3. Toggle harpoon heads from North Pacific tribes, similar in structure to No. 2, with the addition of arrowheads for points; lines woolded with cotton string ---------- 34,397, 74,175

No. 4. Similar in structure to No. 2, with the addition of a barbed harpoon head for point; line in one example woolded. From Nimpkish Indians, British Columbia ---------- 129,980

No. 5. Toggle harpoon head for whale fishing. Body of whale's bone with line hole across the middle; blade of flaked chert inserted in a saw cut in front. Point Barrow, Alaska ---------- 89,749

No. 6. Toggle harpoons from Norton Sound, Alaska. Body of bone; barb single, beveled upwards; blades of slate and ivory; sockets for loose shaft in the butt end; becket of rawhide for attachment to the great line ---------- 169,104, 7,422

No. 7. Toggle harpoon from Alaska, with double barb and steel blade; becket of seal hide; leader, of sinew twine, attaches the blade to the becket; blade cover two pieces of wood lashed together with spruce root, 16,125

No. 8. Toggle harpoon (*Tokung*), from Cumberland Gulf. Body flat and line hole concealed underneath; blade of iron riveted in; barbs two, flat. The type also of western Asia ---------- 34,070

No. 9. Toggle harpoon from Alaska. Body of walrus ivory, with two or three barbs; blades of metal. In this example the loose shaft is shown fixed in its socket. Ornamented after Russian motives ---------- 37,945

No. 10. Toggle harpoon head from Nunivak, Alaska, showing the method of hinging the foreshaft and wooden cover for the head. Body of walrus ivory, with two barbs, decorated ---------- 176,222

No. 11. Toggle harpoons from the Eskimos of Mackenzie River, similar to the foregoing in general outline, but furnished with barbs on the iron blades or on the body. Combination of barbed harpoon head with the toggle harpoon ---------- 3,975, 2,092, 7,422

No. 12. Seal harpoon with toggle head and foreshaft. Line of seal hide; bone detacher ---------- 72,397

No. 13. Toggle harpoon head of iron for swordfish, with hastate point and lateral flukes or barbs; line hole across the middle; shaft works in in socket in the butt ---------- 102,536

SERIES 3.—FISHHOOKS.

Plate 26.

A fishhook is a device for catching aquatic animals by means of a hook. It is a pointed but not a piercing implement. In its simplest form it is merely a bent piece of hard substance pointed at one end and attached to a rod at the other, becoming a gaff, or to a line and becoming a fishhook, properly so called. The parts of a hook are the fluke, the shank, and, later on, the barb. It is always attached to a line held in the hand or suspended from a rod (in which case its use is called angling) or attached to a fixed rope (becoming then a set line or trawl). The manual part of angling devices are not here considered. In order to entice the fish to take the hook, baits and flies are employed. In the fishhook the two processes of hunting water animals are shown—capture and trapping. With the gaff, fish rake, and all such devices the animal is seized and retrieved involuntarily. This series has not undergone much elaboration; but in the baited hook, with its accessories, with the lure and with the fly, human ingenuity has been well nigh exhausted. In the end the taking of intelligent and wary fishes with tackle adapted to the habits of the different species becomes a sport in which large sums of money are paid for single outfits.

No. 1. Fijian fishhook consisting of a curved root, with the bend pointed for fluke, and a line of coconut fiber fastened to the straighter shank_ 3,674

No. 2. Fishhooks from Sandwich Islands and from California, made from a single piece of bone or shell. The first named has braided line, 3,676, 97,828

No. 3. Plain hooks of metal, Peru. A bit of wire bent, pointed at the shorter end and attached to a line at the other________________________ 17,501

No. 4. Halibut hooks from North Pacific coast of America. Shank bent around so as to form a fluke. The barb is provided by bending in the point of the shank or by lashing on a spindle-shape bone, pointed inward__ 72,648

No. 5. Chilkat halibut hook from Alaska, made of a forked stick. The smaller prong acts as shank, with line tied to its middle. An iron spike lashed to the larger prong acts as a barb. It has for a float a piece of wood carved in shape of a duck.

No. 6. Polynesian fishhook. Shank of stone or shell, perforated at the top for a line; fluke of bone or shell, without barb, perforated at the butt and lashed to the shank____________________________ 9,797, 2,844, 8,894

No. 7. Eskimo fishhook from Alaska. Shank of bone or stone carved in form of lures; fluke of metal fixed into the bottom of the shank, 89,550, 153,461

No. 8. Tomcod hook, Eskimo, Plover Bay, Siberia. Single barbed lure, as in No. 11____ 46,264

No. 9. Fishhooks from North Pacific coast of America. Shanks of whalebone and wood; flukes of wood or bone, pointed and lashed at a small angle to the bottom of the shank___________________________ 74,188, 49,172

No. 10. Eskimo fishhooks from Alaska with two or more points of bone__ 40,264

No. 11. Eskimo fishhooks from Alaska in which a barbed spreader has a number of composite hooks attached__________________________________ 44,370

No. 12. Eskimo and Polynesian fishhooks showing a primitive form of the barb; shank of wood or shell; fluke of bone or tortoise shell lashed on the bottom of the shank_____________________________________ 126,984

No. 13. Barbed fishhooks, of shell and metal, with lure________________ 89,545

No. 14. The latest pattern, with steel hooks and artificial bait.

SERIES 4.—SINKERS.

Plate 27.

A sinker is a heavy object attached to a fishing line or net in order to bring the hook into the area of the animal or to hold the line or the net upright in the water. The earliest type of the sinker is a common stone. Such forms would naturally be chosen as would not slip from the line in the water, so notched stones were used. Most savage tribes have discovered that by a peculiar method of lashing they can fix any heavy object in a sling to serve for a sinker. Among civilized peoples metal sinkers of various forms, which include also the characteristics of a lure to entice the animal toward the net or bait, have been substituted for the simpler boulder. In a large collection of sinkers will be found special forms for special fishes, or environments, or appliances. For some uses the sinker must rest on the bottom, as an anchor; for others it drags, as in the drail; for others it is suspended in the water simply as a weight. As with other fishing devices, so with this, there has been a refinement coincident with culture progress. The first fishermen used no lines or sinkers, the latest exhibits a new style of sinker for each kind of fish.

No. 1. Pieces of turtle shell tied to a cord, forming a crude sinker. Bengal, India ____ 103,312

No. 2. Stone sinkers, rough or slightly modified by pecking, lashed in slings of rawhide. Alaskan Eskimos______________________ 63,737, 63,744

No. 3. Stone sinkers notched or grooved for purposes of attachment_ 42,920, 17,837

No. 4. Polished stone sinkers or plummets grooved or notched for suspension. These objects could easily have been fastened in a sling of cord or bark. From mounds of the Ohio Valley________________ 7,790, 42,491

No. 5. Sinkers, ivory or stone, perforated for attachment to a line or net. In one example there is a suggestion of a lure in the form of a small fish_____________________________________ 63,377, 44,935, 56,577

No. 6. Eskimo sinkers of bone or ivory, carved in the form of fishes to act as lures. The Eskimos are clever in making sinkers of this kind to imitate various small animals on which the larger ones prey____ 38, 277, 33,194

No. 7. Eskimo sinkers of bone and colored stones, perforated for suspension. Bottom, of bright colors to attract the fish, ingeniously riveted or lashed to the upper portion. One example is perforated for two sets of hooks____ 46,313, 44,277

No. 8. Polynesian sinker for giant squid, consisting of a shell for lure, a grooved stone for sinker, and sharpened wire flukes in the wooden shaft to excite the animal 4,842
No. 9. Lead sinker from Greece, with wire attachment 103,299
No. 10. Double-gaff hook or drail from Lapland. Lead sinker 28,169
No. 11. Double gaff or drail from Greenland. Sinker of lead, in the form of a fish; extra line attached 103,098
No. 12. Whiffling mackerel line with four flies and spinner 103,112
No. 13. Eskimo fishing line from Point Barrow for catching small cod through the ice, complete; hook, lure, sinker, baleen line, and reel 89,545
No. 14. Scotch codfish hook. Lead lure in form of a fish, painted, to which are attached six barbed hooks 103,153
No. 15. English mackerel and pollock whiffing line with spinner and Challenger bait 103,013

HISTORY OF WEAVING.

The textile art embraces all work in fibers, whether they be vegetal, animal, or mineral. It includes the processes of procuring the fiber from nature, the cleaning and hackling of material, the spinning of yarn, the twisting of thread, twine, or rope, as well as weaving, netting, knitting, lace making, and embroidery. Each one of these several processes has had a development from some natural process, such as the lacing of fiber, the twining of vines, or the web making of spiders. The apparatus at first was of the most simple character, cooperating with human fingers; but in the unfolding of the art the powers of nature and machinery have been called more and more into play. The latest automatic looms are marvelous expressions of the human mind speaking through mechanical devices.

Illustrations of this art are here limited to three series of objects, each showing something of the steps of progress from simple to highly perfected forms. Series 1 represents the spindle, series 2 the shuttle, and series 3 the loom.

WEAVING BY HAND.

Plate 28.

Zuñi Indian woman weaving.—Plaiting with the fingers, as well as the simplest loom work, is done by persons sitting or stooping. The feet are not used, either in decussating the warp or in throwing the shuttle. A simple harness of wood is provided, or one is made by seizing each alternate warp thread and attaching it to a rod. The figure here shown represents a Zuñi Indian woman, of New Mexico, weaving with the blanket loom. The attachment of the warp to an upper and lower beam is an ingenious provision for the tension. The shuttle is a short stick and the batten is a wooden sword. Patterns are wrought by a process of darning the alternate sheds.

SERIES 1.—SPINDLE.

Plate 29.

A spindle is a device for twisting fiber. Human fingers formed the first spindle, and there are now tribes living in British Columbia, Alaska, and other parts of the world where excellent yarn and thread are produced with no instrument whatever. The class of implements called spindles begins with a simple, pointed rod which acts also as a bobbin. It is the first device for converting rectilinear into continuous circular motion. The stick is rolled on the thigh with the palm of the hand, and the twisted fiber is then wound upon this simple shaft. There were added the spindle whorl, the hook at the top of the spindle to enable the operator to walk about, and the fixed bearings by which the apparatus becomes a machine. The band wheel and other devices for multiplying motion led through the large wheel and the small or Saxon wheel to machine spinning.

No. 1. Simple form of spindle. A wooden peg on which yarn or thread is wound.

No. 2. Silk winder. Forked bamboo rod spread for holding wound silk filament. China.

No. 3. Spindle with whorl. Shaft of hard wood; whorl of bone; for winding coarse cedar bark. British Columbia — 20,640

No. 4. Central American spindle. Shaft of palm wood; whorl a hard seed. For spinning cotton yarn — 7,490

No. 5. Peruvian spindle, for fine staple. The thread is looped over the top of the shaft when the spinner walks along — 7,942, 17,510

No. 6. Tibetan spindle. Shaft a twig of cherry, with hook atop; whorl a yak bone. The hook on the spindle shaft enables the spinner to walk about — 167,248

No. 7. Tibetan spindle. Shaft a twig with notch and groove on the top; whorl of clay at the bottom of the shaft. The spinner walks about — 167,247

No. 8. Primitive spinning wheel. Spindle whorls of various materials and forms — 155,598, 195,572, 100,642

No. 9. Shaft set in bearings; whorl enlarged for flywheel. The beginning of machine spindles. Finland — 10

No. 10. Bobbin winder in which the spindle is driven by a primitive flywheel. China — 7,694

No. 11. Model of large spinning wheel for cotton and wool. Simplest form, without speed pulley.

No. 12. Spindle of small or Saxon spinning wheel, with different sized pulleys to regulate speed. The Saxon wheel works with treadle.

No. 13. Spindle used most generally in cotton-spinning machines in the United States. Gift of George Draper and Sons.

SERIES 2.—SHUTTLE.

Plate 30.

The shuttle is a device for passing weft filaments between warp filaments. This process was first performed by the human fingers in plaiting, as in the mat making of the Polynesians, Africans, and

American Indians. The simplest shuttle is a rod on which the weft is wound. Improvements in the shuttle consist of devices for guiding the apparatus more quickly and smoothly between the warp filaments and end in the modern machine shuttle, which is automatically driven with incredible rapidity backward and forward between the "sheds" of the warp. The objects presented in this series are suggestive of the salient features in the line of progress. The Pueblo Indians use a rod of wood and wrap yarn upon it, somewhat as children wind a kite string. A twig with a notch at each end, a slat with closed points, as in netting needles, and hollow stick pointed and furnished with the rudest sort of bobbin have been used by different peoples in the hand epoch of culture. With the domestication of the physical powers and the improvement of the loom the shuttle became more and more effective.

No. 1. Primitive shuttle. Twig of osier, with thread simply wound about it, 151,738

No. 2. Wooden rod with weft wound diagonally about it.

No. 3. Shuttle or antler, pronged at each end. Eskimos of Norton Sound__ 33,266

No. 4. Rag-carpet shuttle. A block of wood notched roughly at each end and used in the domestic hand loom for weaving carpet of rags, coarse chain of jute, cotton, and other materials.

No. 5. Japanese shuttle. Pronged at one end, closed at the other, with "skewer" in the opening______ 19,408

No. 6. Eskimo shuttle. Prongs at either end, approaching each other and pointed______ 163,781

No. 7. Hupa shuttle. Slender shaft, prongs at the ends, approaching like the beak of a bird. California______ 131,151

No. 8. African shuttle. Body toggle-shaped; bobbin a simple cylinder of wood revolving on a splint of palm-leaf stem. Liberia______ 168,079

No. 9. Hand-loom shuttle. Body toggle-shaped; bobbin a hollow reed working on a splint of hard wood______ 7,688

No. 10. Early machine shuttle, of several pieces of wood and iron pointed; open on both faces; bobbin a strip segment of bamboo running on a splint of wood______ 153,172

SERIES 3.—LOOM.

Plate 31.

The loom is a framework on which weaving is done. Essentially it consists, first, of two crossbeams, called the "yarn beam" and the "cloth beam," on which the warp is laid evenly; secondly, the devices for crossing the alternate warp threads, so as to form "sheds," through which the shuttle is passed backward and forward, and, third, of some sort of batten, by means of which the weft is beaten home after the shuttle has made an excursion.

Many other mechanical parts have been added to this machine from time to time; but the simplest loom is a framework in which much

of the operation is still performed by hand, while in the most complicated looms all the operations are performed automatically. In some tribes of our Indians and among rude peoples elsewhere the loom is little better than a darning machine. The fingers are the only harness, and often the side of the hand acts as the batten. In Chinese matting looms and in the belt-weaver's outfit of the southwestern United States the warp is shifted by a wooden harness and the weft is beaten home by a wooden sword. Pedals are not used in any of these early forms, because in all occupations both men and women sit on the ground at their work.

No. 1. Aino loom for weaving belts of ohiyo (elm) bark. Single heald; primitive shuttle; sword batten; warp spreader with holes burnt through.

No. 2. Mexican loom with single heald rod, primitive shuttle, and sword batten.

No. 3. Navaho loom with three heald rods, sword batten, and weft of different colors in hanks, not in shuttles.

No. 4. Babylonian loom with four sets of healds and reed batten.

No. 5. Heddle cut from a single board. Other examples are made of reeds held in parallel crosspieces.

No. 6. Italian loom, same as No. 5, in its heddle, with yarn beam and ratchet.

HISTORY OF METAL WORKING.

Among savages, generally, the ores of metals and pure nuggets of copper, gold, and silver are treated as stone. They are chipped, battered, abraded, and polished. A little higher in culture the softer metals are cold hammered, or cut, or pressed into shape, and in some cases, swaged. The third step in the elaboration of this art is found among those African tribes that have iron ore in sufficient purity to reduce it in an open forge. The smelting of metal comes last, and this portion of the art gives rise to an infinite number of modern industries.

In the reduction of metals the first and simplest process is "heap roasting"; the second is the "open-hearth roasting"; next comes the earth hearth with a cavity, which is the primitive crucible. This is followed in order by the crucible without draft, the crucible with draft, natural or forced, and the crucible with a flame playing above and below, leading up to the reverberatory furnace with its hot blast. The electrical furnace, without fuel, is the latest step in the process.

After the crude substance has been rendered tractable it is then the object of innumerable manipulations, the consideration of which would form the second series of exhibits. The tools employed at first in metal working were of stone, then of metal held in the hand. Finally, a wide range of machine tools has been devised for the purpose of manufacturing objects of use and beauty.

PRIMITIVE METAL WORKING.

Plate 32.

Navaho Indians making silver ornaments.—The Navaho Indians of Arizona and New Mexico were taught a rude sort of metal working by the Spanish conquerors, and they have become very adept in the use of their primitive tools and apparatus. It is not known that they mined for silver, all of their products being made from Mexican and American coins. The silver is either cold hammered or melted in open crucibles by the use of charcoal and flux, with blast produced by bellows having two air sacks of leather, as crude as those of the Congo Negroes. Much metal is wasted in the operation. It is brought into final shape by hammering, punching, chasing, and engraving. The objects made are mainly personal ornaments, such as buttons, ear ornaments, beads, and bracelets. Examples are placed with the figures.

SERIES 1.—REDUCTION IN METAL WORKING.

Plate 33.

By this phrase is meant those arts that are practiced upon metals in order to prepare them for the manufacture of useful things.

This series begins with those metallic ores which were treated by the lower races after their manner of stoneworking, for paint, for simple tools, or for ornaments. The next steps in these primitive processes are the cold hammering of ores, the forging of rich ores, smelting, casting, riveting, welding, alloying, and soldering. In each case a bettering of tools and a complication of wants would go hand in hand.

No. 1. Nuggets of iron ore, slightly modified, from the mounds of Kentucky.
No. 2. Pieces of iron ore modified by flaking and rubbing to form the blades of common tools. Mounds of the Mississippi Valley, 90,733, 19,601, 62,024
No. 3. Pieces of iron ore polished. Mounds of the Mississippi Valley, 34,652, 34,521
No. 4. Pieces of crude copper ore cold hammered into shape. Lake Superior region 1,136, 31,937
No. 5. Copper cold hammered into sheet and arrowhead. Mounds of Ohio and Michigan 10,213, 113,733
No. 6. Sheets of copper cold hammered into shape and perforated. Embossed by punching. Mounds of Wisconsin 88,387, 90,737
No. 7. Sheet of copper crimped and corrugated by hammering. Mounds and Northwest coast 61,174, 67,947
No. 8. Copper cast into form of ancient half-socketed ax or adz. Wisconsin.
No. 9. Bronze hatchet blades from Europe. Casts showing the steps in the art of socketing 140,721, 101,109. 10,116
No. 10. Cast-iron fish, showing the latest results of fine casting 95,021

No. 11. Example of rude forging. Angola, Africa ---------- 131,311

No. 12. Example of anvil work and swaging of a rude kind. Angola, Africa, 153,176

No. 13. Example of common welding or uniting two pieces of the same metal by heating in open fire with a flux and hammering them together.

No. 14. Example of riveting two pieces of iron together with pegs of the same metal.

No. 15. Example of uniting two edges of metal by soldering or brazing -- 167,854

SERIES 2.—MANUFACTURES IN METAL WORKING.

Plate 34.

The processes of metal working include all of those arts which go by the general names of hammering, casting, overlaying, inlaying, damascening, swaging, twisting, linking, chasing, embossing, carving, niello work, and others of a more refined character. They are embraced in the general term of manufactures or elaborative industries. For each process there is a craft with its own appliances, tools, and processes, creating and supplying new wants. In the series here shown the results of these processes are set forth in the order of their refinement, although the presentation is far from complete.

No. 1. Overlaying with cold metal. Stilletto or staff of wood; handle overlaid with thin sheets of copper pressed into depressions of the wood and marked with crosslines. Congo region, Africa ---------- 174,743

No. 2. Armlets and necklaces in twisted wire and metal beads. Africa -- 174,723

No. 3. Glove belonging to ancient armor. This specimen shows the method of wireworking in armor-forming chain mail.

No. 4. Edged weapon with socket, showing raised work on the surface. West Africa ---------- 169,255

No. 5. Double-bladed dagger from the northwest coast of America. Siberian type. Blade fluted and punched into the suggestion of a wolf's head and inlaid with haliotis shell ---------- 9,936

No. 6. African knife in common use among the Congo natives. Surface of the blade punched in lines to form a leaf-shaped pattern ---------- 130,931

No. 7. Brass plate, Turkish pattern. Surface chased and decorated by punching ---------- 76,542

No. 8. Brass work chased, punched, and carved in geometric patterns. Piece in the center scraped ---------- 169,233

No. 9. Scabbard of a dagger. Example of embossed or repoussé work.

No. 10. Simple inlaying. Lead in pipestone, Sioux Indians; silver in iron, Korea ---------- 130,786, 77,038

No. 11. Knife and sheath from Cordoba, Spain. Sheath of brass, chased; blade steel, with brass ornaments set in ---------- 167,569

No. 12. Siamese dish of silver, the flattened border ornamented with overlaying in gold, embossed figures, the interstices filled with black cement.

SERIES 3.—TOOLS AND APPLIANCES USED IN METAL WORKING.

Plate 35–37.

This series includes all tools used in working metals, only a few of which are here exhibited, namely, the hammer, the drill, the punch,

the pincers, and the bellows. The latest manifestations of this series are found in trip hammers, rolling mills, hydraulic welding and riveting, traveling derricks, which are only elaborated tongs, and the host of mechanical tools in foundries and machine shops.

No. 1. Stone hammer from Gaboon, Africa — 154,088
No. 2. Japanese hammer. Head a plain cylinder of iron; helve of oak, fitting into a rectangular eye in the head — 19,460
No. 3. Ordinary smith's hammer. The face is octagonal and the peen is wedge-shaped; handle hickory; eye oval — 166,679
No. 4. Modern blacksmith's hammer. Face circular; poll flat and distinctly outlined; peen wedge-shaped, constricted at the top; handle hickory; eye oval.
No. 5. Japanese jeweler's hammer, with poll and face of uniform size. Rectangular peen, long, pyramidal, and pointed; handle of oak set in a square eye — 19,461
No. 6. Japanese jeweler's anvil. Thick spike of iron, with the upper portion squared and polished for hammering — 19,461
No. 7. Model of a pump drill, all of iron. Used in country blacksmith shops for boring carriage tires — 126,744
No. 8. A country blacksmith shop (pl. 36).
No. 9. Tibetan bellows without valves. The air is let into the goatskin by opening the end and forced out by closing it. (No cut.) — 175,321
No. 10. Double bellows with simple valves of monkey fur. Gaboon, Africa (pl. 37) — 164,873
No. 11. Common bellows used in houses 70 years ago.
No. 12. Dividers, with loop for setting — 167,879
No. 13. Square-faced tongs or nippers — 168,747
No. 14. Pincers for drawing nails — 19,430
No. 15. Dividers for gauging.
No. 16. Copies of ancient molds in which socketed axes were cast. Bronze Age — 139,755

HISTORY OF MUSICAL INSTRUMENTS.

Musical instruments have had an interesting history on account of the great development which has taken place along four lines, each furnishing a tremendous variety of instruments. This history is early shown on account of the numerous surviving examples of every type of invention connected with the subject. The following text will give a clear idea of the development.

SERIES 1.—PERCUSSIVE INSTRUMENTS OF MUSIC.

Plates 38–39.

The earliest and simplest function of music was to mark time in singing and acting. Later came melody and harmony. Even those instruments that simply mark time belong to several classes—those with no determined tone, such as rattles, cymbals, gongs, and bells, or those that have some determined tone, as the xylophone, gong chimes, and bell chimes. Another branch of these instruments are

picked, such as the jew's-harp and music boxes. A third branch would involve instruments that are rubbed, like the musical glasses. This series terminates with examples in which membrane is used, such as hand drums and military drums, and presents, in outline only, progress in the development of percussive or autophonous musical instruments.

No. 1. Hopi rattle of gourd. Handle the neck of the gourd. Arizona---- 94,637
No. 2. Hopi rattle (*mu-shi-la*). Flat gourd with wooden handle passing through. Arizona---- 11,787
No. 3. Rawhide bag inclosing pebbles and seeds. Sioux---- 165,685
No. 4. Rattle of plaited fiber, with pebbles inside. British Guiana---- 54,186
No. 5. Tlingit rattle carved in imitation of a fish hawk. Southeastern Alaska---- 88,727
No. 6. Rattle made of cocoons of moth fastened to twigs. California.
No. 7. Clallam rattle. Pecten shells strung on wooden hoop; ornamented with feathers and colored cloths. Washington State---- 13,117
No. 8. Tortoise shell, with dewclaws of deer on leather thongs for clappers. Arizona---- 68,791
No. 9. African rattle. Wrought-iron disk with handle, to the border of which are hung iron bells. Congo---- 174,748
No. 10. Hupa rattle. Cloth belt, to which are attached pendants of deer hoofs, ornamented with beads. California---- 77,190
No. 11. Brahman and Mohammedan anklet rattle, Hindustan. Rope of grelots or hawk bells worn by both sexes and held sacred. Put on with special religious ceremonies---- 92,717
No. 12. Musical bones or clappers. Used chiefly by minstrel bands in America---- 55,727
No. 13. Chinese clappers (*chut-pan*). Three tablets of hard wood united by a string piercing all of them---- 96,567
No. 14. Sheep bones strung on a cord, forming a rattle. Spain.
No. 15. Block of hardwood hollowed through an incision in the side. China.
No. 16. Fijian war drum (*sa li*). Log of wood hollowed like a canoe, ornamented with beads inlaid. Struck with wooden club---- 23,949
No. 17. Tambourine made by pegging skin over a wooden hoop. American Indian.
No. 18. Hindu kettledrum (*tabla*). Sonorousness increased by weighting the head with a circular patch of black cement. Struck with the finger---- 92,726
No. 19. Japanese two-headed drum (*kah ka*). Head larger than the body. Different tones are produced by striking in the center or at the edge---- 94,954
No. 20. Chinese gong (*lo*) of bronze. Peculiar to the Far East, having a bossed or raised center and the rim turned back a little more than a right angle---- 94,850
No. 21. Chinese cymbal (*po*). Made of hammered bell metal in shape of Chinese hat---- 94,861

SERIES 2.—OPEN-STRINGED INSTRUMENTS OF MUSIC.

Plates 40 and 41.

Stringed instruments are divided into two classes, namely, open and stopped, and each of these is subdivided into the picked, the

struck, and the rubbed, according to the method in which their strings are set into vibration. The most simple form of the open-stringed instruments is a musical bow, which is both picked and struck, and the most complex forms are the harp, the dulcimer, the harpsichord, and the piano. The stopped-stringed is one whose vibratory length may be shortened, thus raising the pitch and making it possible to produce on a single string one or more octaves, with all the chromatic intervals. Of the stopped strings a simple form is the African zeze, which has only two frets and often but one string, while the most complex forms are the lutes, guitars, and violins. The few examples here shown illustrate the progress of invention in perfecting the open-stringed instruments.

No. 1. Mahuga musical bow, from Mashonaland. Piece of cane with single string of twisted cotton. Player holds it in his teeth to hear the sound ---------- 167,518

No. 2. Angola musical bow. Plain stick for bow; string of twisted hemp cord; gourd resonator tied to grip of the bow; open part of gourd rests against the stomach of the player; inclining the gourd gives two or three tones (pl. 41) ---------- 167,517

No. 3. Egyptian tambour or African lyre. Body boat-shaped, covered with rawhide; neck a bent stick; strings twisted fiber, reaching from median line of the body to the overhanging neck; tuning pegs transverse.

No. 4. Finnish open-stringed psaltery (*kantele*). Wire strings, of graduated length stretched over wooden pegs tightened by wire keys ---------- 95,690

No. 5. Kanoon, from Morocco. Body, a trapezoid; gut strings of graduated lengths tuned in groups of threes; fixed bridge at oblique end; raised bridge resting on four squares of fish skin. Sound holes in sounding-board.

No. 6. Italian psalteria or dulcimer. Trapeze formed body. Series of strings of graduated length, tuned in groups of four each. Fixed bridges at each end of sounding board, and two diagonal rows resting on it.

No. 7. Autoharp. Harmonics only are sounded. Inharmonic sounds dampened by pressing down a series of spring bars ---------- 95,237

SERIES 3.—WIND INSTRUMENTS OF MUSIC.

Plate 42.

Wind instruments are divided into several classes, namely, horns, flutes, flageolets, flue-organ pipes, and reed instruments. Horns are musical tubes in which the lips of the player set the column of air within the tube into vibration. The longer the tube of a horn the lower the note produced, the greater the number of harmonics that can be obtained by varying the pressure and velocity of sound passing through the tube. There are two methods of changing the pitch of the fundamental note of a horn, and consequently its harmonics; first, by adding to the length of the windway, either by a sliding joint, as in the trombone, or by adding fixed lengths of the windway, as in cornets and other similar instruments; second, by placing lat-

eral holes in the tubing, which can be opened or closed by the finger or by valves, which has the same effect of raising the pitch as by shortening the vibratory length of the cords in a stringed instrument. The old zink, serpent, and key bugle are of this class.

No. 1. Fiji conch shell with mouth hole in the side of the spiral........ 3,825

No. 2. Burmese horn made from the horn of a buffalo.................. 95,509

No. 3. Finnish wooden horn (*soittotorbi*), bottle-shaped. Made of two sections of wood, with long neck, bound together with birch bark...... 95,684

No. 4. Bamboo horn from Philippine Islands, open at one end, closed at the other. Mouthpiece a cylinder of bamboo set on the side; bent bamboo sections to imitate crooks and valves of European cornet...... 95,054

No. 5. United States Army regulation cavalry trumpet. Tube bent on itself in two coils; mouth trumpet-shaped.............................. 55,606

No. 6. French horn. Brass tube bent three times on itself; mouth trumpet-shaped. Tones are produced by the player's hand moved in the bell.. 95,269

No. 7. Finnish trumpet (*soitto sarvi*) of ram's horn, with four finger holes on the side of the instrument. Bore the natural cavity........... 95,689

No. 8. Key bugle with lateral holes closed by seven finger keys. Bore conical; size of finger holes corresponding to size of bore.............. 95,652

No. 9. Ophicleide. Conical tube bent on itself; lateral holes closed by finger keys; size of finger holes corresponding to diameter of bore.... 95,272

No. 10. Trombone, old English sackbut. Cylindrical tube of brass, with sliding joint long enough to give seven tones; mouth trumpet shape. The chromatic scale is thus produced.

No. 11. Cornet with cylindrical tube and trumpet-shaped bell. Piston valves three, which add different fixed lengths of tubing to the windway 55,602

SERIES 4.—REED INSTRUMENTS OF MUSIC.

Plate 43.

Reed instruments are of two classes, namely, the double and the single, and it is doubtful which is the more primitive. Should one take a straw and bite off one end square, the act of biting the straw would flatten the tube, and thus form a simple double reed, whereas to form a single reed of such material one should take a section of straw, open it at the lower end, with the upper end closed by the joint, then with a sharp instrument cut a short distance into the tube and split the section an inch or two, and he would form the vibrating tongue of a single reed. Either method, with finger holes cut or burnt in the tube, would form the rustic oaten pipe. Single reeds are of two kinds—the beating and the free. The beating reed is formed of wood, metal, etc., the width and length of its vibrating tongue being sufficient to allow it to strike against the walls of the tube or mouthpiece, as seen in the clarinet or instruments of its class. The free reed is usually made of metal. In this form the vibrating tongue is slightly narrower and shorter than the opening in the metallic overplate, to which it is firmly fastened, so that it vibrates

without touching at its sides or free end the opening in this plate. It was first introduced into Europe in 1770 by Prof. Kratzenstein, of St. Petersburg, but it was known in the Far East, as seen in the Chinese Ching and instruments of the same class in Japan, Siam, Burmah, and the Malay Archipelago. Examples of the free reed are the harmonicon, mouth organ, accordion, and reed organ.

No. 1. Chinese shalm or shawm (*ch'iang-ti*). Section of bamboo with thumb hole and seven finger holes; double reed, a section of thin reed scraped down and flattened ---------- 94,864

No. 2. Korean shalm (*piri*). Double reed, a section of bamboo worked down and flattened; thumb hole and seven finger holes ---------- 95,211

No. 3. Chinese oboe (*k'ai-ti*). Tube of wood with conical bore; one thumb hole and seven finger holes; mouth tube of brass, tapering; reed, section of rice stalks tied on brass tube ---------- 96,575

No. 4. Oboe or hautboy. Tube of wood; bore conical; four joints, six finger holes, and thumb keys; mouth tube of brass; double reed of two pieces of cane ---------- 95,290

No. 5. Egyptian clarinet (*zummarah*). Tube, section of bamboo open at both ends; finger holes four; reed smaller section of bamboo, with tongue cut and split on one side.

No. 6. Arabic double clarinet (*mijwiz*). Tubes two, of cane, with four finger holes each, and two reeds also of cane. Similar to that of the zummarah ---------- 92,863

No. 7. European fagot or bassoon. Tube in four parts, of maple, with conical bore, six finger holes, and eight keys; double reed of two pieces of cane; mouthpiece set on a wing ---------- 95,275

No. 8. Clarinet. Tube and bell of boxwood, with a conical bore, one thumb hole, seven finger holes, and six keys; mouthpiece of rosewood, with a single beating reed of cane lashed to it ---------- 55,618

No. 9. Inverted double reed from Fort Simpson, Alaska. A tapering cylinder of wood split, excavated to form a tube open at the upper end and closed at the lower. The stock is then bound around with leather thongs ---------- 20,700

No. 10. Double inverted reed instrument from Bella Bella Indians. The same as No. 9, but with the lashings perfect ---------- 20,699

No. 11. Italian bagpipes (*zampogna*). Bag the skin of a sheep. The pipes start from a wooden stock inserted in the neck of the skin. It has one chanter and three drones. Mouth tube of wood, set in one of the legs of the animal ---------- 95,047

No. 12. Harmonica or mouth organ. A free-reed instrument without tubes, 55,662

No. 13. Accordion. A free-reed instrument with a double bellows and keyboard ---------- 55,638

No. 14. Cheng. Chinese mouth organ and free-reed instrument, with tubes, 96,657

No. 15. Jew's-harps. A variety of reed instruments in which the vibration is made by the finger of the player. The cavity of his mouth acts as a resonator ---------- 95,559 (2), 94,651

No. 16. Japanese jew's-harp (*mokuri*). In this the tongue is vibrated by a string attached to it near its base ---------- 150,720

No. 17. Wooden jew's-harp from Sulu. This differs from the preceding in that the frame of the instrument is vibrated instead of the tongue -- 5,692

HISTORY OF THE CERAMIC ART.

Clay working is one of the arts most widespread in space and time. The industry has had part in all phases of material progress, and the imperishable products of the clay worker form one of the most valuable indices of the stages of civilization. Included under the head of ceramics are glass and enamel, which appear to have developed with the facilities of increasing heat in ceramic and metallurgical processes.

The ceramic art includes the production of all objects formed by modeling, molding, and baking clay. The classes of products are vessels, statuary, architectural details, and miscellaneous objects of almost endless variety. This art has been practiced by nearly all peoples that have passed into what is known as the upper status of savagery. The beginnings were extremely simple, but the highest products are marvels of industrial and esthetic achievement.

The history of this art, from its inception to its fullest development, is illustrated here in epitome by two series of exhibits, one comprising the products and the other the implements and appliances of manufacture. The principal series begins with the rudest forms of earthenware and ends with porcelain. The second begins with archaic modeling tools and closes with the wheel and the mold. Firing devices are omitted for want of room, and no attempt is made to present the varied and interesting phenomena of embellishment.

One form of pottery—the vase—is taken to represent the entire range of products.

Short series of objects representing glass and enamel are placed with ceramics proper, bearing the relations of offshoots from the main stem.

Although no single people has passed through precisely the stages of progress here indicated, the pottery industry of all civilized nations must have had a somewhat analogous succession of phases. These series, therefore, illustrate with reasonable accuracy the general history of the art as practiced by mankind, and especially indicate something of the growth and conquests of the human mind.

FIRST STEPS IN CERAMICS.

Plate 44.

Zuñi Indian women making pottery vases.—The woman is the potter among very primitive peoples. She digs the clay, cleanses and mixes it, and when the paste acquires the proper consistency rolls it and builds the vessel. The rolls are added to the edges of the incipient vessel and pressed into place, one after another, until the desired height is reached. Paddles and other tools are used in

shaping and finishing, and the firing or baking is accomplished without the aid of a furnace.

In the center (pl. 41) is a Zuñi woman building up and smoothing the walls of a vase, using her fingers. When the shape is perfected, a white wash is put on, and the surface is polished with a smooth stone (right). The other woman paints the design in black and red pigments with rude brushes (left), and the baking is later accomplished in a hot fire.

Finished specimens of the work are shown.

SERIES 1.—IMPLEMENTS USED IN POTTERY MAKING.

Plate 45.

The processes involved in the manufacture of earthenware are varied, and the course of their development is perhaps better understood than are the processes of other arts, because the plastic clay has received and preserved the record in ways peculiar to itself. The implements and devices are of several classes. There are the modeling tools, bits of gourd (No. 1), shell, wood, or bone; the modeling-texturing tools, which serve for shaping and decorating at one and the same time (Nos. 2 and 3); the polishing stones (No. 4); the incising tools (No. 6); the brush (No. 7); stamps (No. 8); the mold (No. 9). Besides these there are devices for baking or firing, glazing, and ornamenting, not shown here for want of room.

No. 1. Modeling-texturing tools. Rolled back and forth over the soft clay. Algonquian and Pueblo Indians ---------------------------- 165,372

No. 2. Modeling implements made of gourd shell. Pueblo Indians ----- 47,925, 165,373 (2)

No. 3. Modeling-texturing paddles. Used in shaping and finishing earthenware. Cherokee and Mohave Indians ------------------------ 10,329, 132,990

No. 4. Polishing stones. Used in shaping and finishing earthenware. Various Indian tribes -------------------------------- 82, 953, 76,081, 197,124

No. 5. Pointed tools used in incised decoration. Roman stylus and Indian needles ------- 115,575, 101, 795, (no number), 141,002, 126,610, 101,792

No. 6. Modeling and decorating tools used by Mexican Indians -------- 126,600, 126,695, 126,594, 126,610, 126,597

No. 7. Brushes of hair, frayed bark cord, and chewed straws, used in decorating pottery ---------------------------- 126,635 (3), 126,601 (3), 2476

No. 8. Earthenware stamps for decorating pottery and impressions from them. Mexico -- 133,195, 133,188

No. 9. Mold for shaping an ornament. Sèvres, France.

SERIES 2.—VASE.

Plates 46 and 47.

From the whole field of products of the ceramic art the vase alone is chosen for illustration in this exhibit. The simplest forms are the rude, unpolished cups and bowls of primitive tribes (Nos. 1, 2, and 3).

Somewhat higher in the scale are Nos. 4 and 5, which have slightly polished surfaces and rudely incised decorative designs. Following these are examples illustrating advances in polishing, painting, stamping, casting, and throwing on the wheel. Glazing came in with or shortly after the invention of the fixed wheel. In the latter part of the series are shown illustrations of the higher forms of shaping, surfacing, decorating, and firing, closing with that marvelous product, porcelain.

No. 1. Cup from a grave in Arkansas. Simplest form of vessel; hand shaped; hand finished; Middle Stone Age ---------- 91,040

No. 2. Bowl of the Andaman Islanders, one of the most primitive pottery-making peoples known. Hand made; hand finished; Middle Stone Age ---------- 164,750

No. 3. Rude hand-made cup; simple incised decoration; Eskimos, Alaska; Middle Stone Age ---------- 33,073

No. 4. Incised cup of archaic character from a grave in Arkansas. Hand made; stone smoothed; incised decoration ---------- 71,465

No. 5. Vase of simple type. Stone polished; incised decoration; Bronze Age; Switzerland. Culture of people, all phases considered, inferior to that of mound builders of Mississippi Valley ---------- 100,820

No. 6. Coil-built vessel; ancient Pueblo, Arizona; Middle Stone Age ---- 155,241

No. 7. Mound builder's bottle. Polished; decorated with incised lines in highly developed combinations; Advanced Stone Age—Copper Age (?) - 87,710

No. 8. Mound-builders's jar. Beginning of color decoration. Polished with stone implement; painted with brush; Advanced Stone Age—Copper Age (?) ---------- 90,958

No. 9. Ancient Pueblo vase, Arizona. Stone polished; geometric painted designs; Advanced Stone Age ---------- 114,866

No. 10. Vase from grave in Chiriqui, Panama. Hand built; stone polished; brush decoration; Late Stone Age—Copper Age (?) ---------- 132,974

No. 11. Vase from grave in Chiriqui, Panama. Refined shape suggesting Greek outlines; hand made; plain finish; Advanced Stone Age—Copper Age (?) ---------- 108,475

No. 12. Ancient Mexican vase. Hand made; stone polished; polychrome decoration; Late Stone Age—Copper Age (?) ---------- 132,974

No. 13. Ancient Peruvian bottle. Pressed in shell mold; hand finished; stone polished; Advanced Stone Age—Copper Age (?) ---------- 1,397

No. 14. Ancient Peruvian whistling bottle. Pressed in figured molds in parts and joined; stone polished; Advanced Stone Age—Copper Age (?), 107,552

No. 15. Spanish-American bottle. Turned on rude wheel; stone polished; washed with color; Iron Age.

No. 16. Ancient Cypriote bottle. Turned on wheel; plain finish; Bronze Age or Iron Age ---------- 101,834

No. 17. Ancient Korean jar. Turned on simple wheel; hard burned; beginning of glaze; Bronze Age or Iron Age ---------- 94,518–15

No. 18. Ancient Korean jar. Turned on simple wheel; hard burned; glazed; Bronze Age or Iron Age ---------- 94,518–31

No. 19. Spanish-American bottle. Hand modeled; elementary glaze; Iron Age.

No. 20. Spanish-American pitcher. Turned on simple wheel; fully glazed; Iron Age ---------- 176,799

No. 21. Old English stoneware. Turned on wheel; slight glaze; Iron Age. 140,006
No. 22. Italian faïence jar. Turned on wheel; soft paste; stanniferous glaze ---------- 94,977
No. 23. Faïence bottle; Kioto, Japan; crackled glaze ---------- 93,431
No. 24. Bottle, English; heavy glaze.
No. 25. Faïence bottle; Satsuma; enamel and gilt. Japan ---------- 94,734
No. 26. Bottle; colored enamels; Kioto, Japan ---------- 94,578
No. 27. Porcelain jar; Copenhagen, Denmark.

SERIES 5.—POTTER'S WHEEL.

Plate 48.

The potter's wheel was at first merely a crude device for turning the work to a proper position in front of the potter without deforming it. The support for the vessel may have been a slab of stone at first lifted into the required position by the potter. Then the necessity of freer movement would cause the use of supports which rotate haltingly at first and gradually more freely, moved by the hand of the potter. A vast improvement is seen in the continuously rotating wheel moved by muscular energy at a speed sufficient to admit of "spinning" the clay. Previously the clay was worked with the wheel at rest between turnings to position, the vessel being built up painstakingly with coil on coil of clay. Now clay in mass is made to soar into form and the world-wide economic stage of ceramics is born.

It is possible that in early times a dish-shaped stone was used for supporting and revolving the vessel while in process of building, as among the Pueblo Indians.

No. 1. Shallow earthenware dish used for supporting and revolving the vessel while in process of building. Pueblo Indians.
No. 2. Cylindrical block, a form of wheel in use by the primitive potters of Yucatan. It is revolved between the soles of the potter's feet on a soaped or greased board while the shaping of the vessel goes on.
No. 3. Egyptian wheel, restored from an ancient mural painting.
No. 4. Kick wheel of simple form. The feet of the potter are employed to revolve a disk attached by a vertical shaft to the wheel upon which the modeling is done.
No. 5. Kick wheel in which the wheel is revolved by a lever operated by the potter's foot.
No. 6. Wheel with mechanical contrivance for relieving the potter of the necessity of operating the wheel.
No. 7. Model of wheel of highest type. Rookwood pottery, Cincinnati, Ohio.

SERIES 4.—GLASS.

Plate 49.

The use of glass began in prehistoric times, doubtless in what is known as the Bronze Age. The accidental melting of silicious material in pottery kilns and in furnaces for reducing metals naturally led to the manipulation of the plastic substance, and the beauty of

the product gave it value for ornamental purposes. Scenes illustrating glass blowing are sculptured on the walls of ancient Egyptian tombs. Other eastern peoples practiced the art with surprising skill at an early date. It is difficult to secure specimens to illustrate either the steps of progress in glassmaking or the articles produced by the various nations. Strangely enough it can not be said that the moderns have advanced beyond the ancients in the art of working in glass, save perhaps in the invention of mechanical devices for shaping and in expansion of use. It is a question whether we are able to imitate some forms of their work. There really are no primitive steps in this art, since culture must have been well advanced before the properties of the materials were discovered or the necessary processes developed.

No. 1. Volcanic glass—obsidian. Natural product.
No. 2. Furnace slag—glass. Accidental product of such as may have suggested use of glass.
No. 3. Glass ornament; head of hairpin; Bronze Age. Europe---------- 101,341
No. 4. Ancient Roman glass; toilet bottle---------------------------- 101,906
No. 5. Ancient Roman glass; toilet bottle---------------------------- 95,840
No. 6. Modern glass; American; Tiffany------------------------------- 96,446
No. 7. Modern glass; American; Tiffany------------------------------- 96,438
No. 8. Modern glass; American; Tiffany.

SERIES 5.—ENAMEL.

Plate 49.

The discovery of processes by means of which glassy compounds could be produced on or applied to the surface of earthenware by the aid of fusion opened new fields to the worker in clay and the decorator of metal. When the glassy substance is distributed in a more or less transparent film over the surface of objects treated, it is usually classed as glaze, but when rendered opaque by the addition of color, and especially when applied in thick bodies as decoration, it is known as enamel. As applied to metal surfaces there are three well-marked varieties—surface enamel, champlevé enamel, and cloisonné enamel. In the first vase (No. 1) the colored glass is applied to the plain metal surface; in the second vase (No. 2) it fills in designs excavated in the surface of the metal; and in third vase (No. 3) the design is outlined by metal wire fixed to the surface and then filled with colored glass. Five successive stages in the progress of the latter work are shown.

No. 1. Vase; porcelain with lacquer—cloisonné decoration.
No. 2. Vase; enamel on metal. China.
No. 3. Five successive stages in the cloisonné process. Japan.

HISTORY OF SCULPTURE.

The term sculpture is here applied to the whole range of processes and products pertaining to the shaping of stone, but is not extended

to the modeling of pastic materials, the shaping of metal or the carving of wood, bone, ivory, or other hard substances. The history of this art, briefly epitomized here, constitutes a most important chapter in the record of human progress, for its products tell an eloquent story of technical development and at the same time preserve invaluable records of the history of religion, esthetics, and general culture. It is observed that with very primitive peoples the shaped forms are implements and utensils merely, but that with advancing culture life forms, generally as symbols, gradually appear, and that in civilization realistic and ideal phases are prevalent.

A striking illustration of the condition of the art among primitive races is found in the work of the prehistoric peoples of central, northern, and western Europe. Examples of this work are shown in series 1. This phase of sculptural development is duplicated in the more primitive stages of our native American work (series 2, Nos. 1 to 6), but many of the American tribes had advanced far beyond this, and, as seen in the continuation of series 2, had acquired very considerable skill and taste in the treatment of life forms. Series 3 illustrates the tools and utensils employed in the art.

FIRST STEPS IN SCULPTURE.

Plate 50.

Indian flint flakers.—Primitive peoples shape stones by four processes—flaking, pecking, abrading, and cutting. Fracture processes were probably first to come into general use. Splinters or flakes produced by striking one brittle stone against another become useful as arrowheads, knives, perforators, and scrapers. Skillful flaking enables the workman to shape implements with great neatness. Larger implements were made by flaking an entire stone, thus reducing it to the form of a blade. The most remarkable work of this class known is that observed in a variety of large flint knife found occasionally in ancient Egyptian tombs.

The figures here shown represent Powhatan Indians, of Virginia, engaged in shaping rude implements from quartzite bowlders. The scene is laid in the ancient quarries on Piney Branch, near Sixteenth Street, in Washington City, where vast numbers of implements were made by the aboriginal occupants of this part of the Potomac Valley.

SERIES 1.—EUROPEAN SCULPTURE.

Plate 51.

No. 1. Simplest forms of shaped stone; paleolithic implements; England. Process: Flaking with stone hammers ---------- 172,644

No. 2. Simple flakes used as tools; also cores from which they are struck. Europe ---------- 99,881, 99,908

No. 3. Neatly shaped implements; Stone Age; Europe. Process: Flaking by percussion and possibly also by pressure---------- 1,922, 35,144, 287,972

No. 4. Highest forms of European flaked implements; upper limit of shaping by flaking process; Stone Age---------------------- 100,968, 101,074

No. 5. Implement roughed out by flaking hammers and finished by abrading process. Northern Europe------------------------------------ 136,738

No. 6. Implements reduced to general shape by pecking and finished by abrading process. Europe-------------------------------------- 100,614(2)

No. 7. Highest forms of shaped stone produced by Bronze Age races of Central Europe. Pecking-abrading processes ------------------------ 100,720

SERIES 2.—ABORIGINAL AMERICAN SCULPTURE.

Plates 52–54.

The American tribes seem to have displayed a strong predeliction for sculpture. They shaped their stone implements with great skill and delighted in the representing of animal forms. Religious motives inspired most of the more elaborate work, although esthetic appreciation was not wanting.

The series of objects here presented covers nearly the full range of native achievement, although the best examples shown fall far short of the highest types of Aztec and Maya work. The simplest forms are shown in plate 52, and a series of progressive steps lead up to the higher forms in plates 53, 54. It is believed by some that germs of culture have occasionally reached America from other lands and that sculpture on this continent is not wholly of native growth.

Many tribes are still practicing the lowest forms of the art, while others, such as the Northwest coast peoples, are well advanced.

No. 1. Simple flakes used as implements and worked into useful forms; also a core like those from which they were struck. American Indians.

No. 2. Implement roughed out by flaking a single stone--------------- 169,943

No. 3. Progressive form from a single stone---------------------------- 202,105

No. 4. Further work in producing a flat blade-------------------------- 208,109

No. 5. Finely worked implement made by skillful chipping. Missouri--- 137,927

No. 6. Implements roughed out by flaking and finished by abrading processes, 85,276, 116,272, 147,668

No. 7. Highest type of form and finish by this process. Porto Rico, West Indies-- 16,902

No. 8. Celt showing work in representing a human figure. Elementary life-form sculpture. Santo Domingo---------------------------- 220,535

No. 9. Implement roughed out by pecking. Georgia-------------------- 170,895

No. 10. Pecked implement, partly smoothed surface. Georgia---------- 170,333

No. 11. Highly finished stone ax worked into shape by pecking. West Virginia--- 90,512

No. 12. Stone hammer, showing rude sculpture by pecking. Elementary stage of life-form sculpture. Alaska.

No. 13. Human figure. Water-worn stone modified to represent features in relief. New Mexico.

No. 14. Human figure. Block of stone with most work done in freeing the head. Kentucky.

No. 15. Human figures. Block of hard stone with head worked out. Mexico.

No. 16. Human figure. Head and legs worked out, body a mere block.

No. 17. Human figure. Body, head, and arms posed and well worked out in the round.

No. 18. Human figure with free limbs. Worked in relief and posed. Costa Rica.

No. 19. Human and animal figures posed and in action. American Indians. Northwest coast.

No. 20. Masks in serpentine and onyx, showing appreciation of facial characters. Larger mask probably a portrait. Mexico. (Three to right in lower row.

SERIES 3.—IMPLEMENTS USED IN SHAPING STONE.

.Plates 55 and 56.

The series begins with the stone hammer, used very generally by primitive peoples in shaping stone. Analogous forms of the tool occur the world over, and European and American forms are identical. In shaping brittle stone the discoid or globular hammer (Nos. 1, 2, and 4) is held in the hand and flakes are removed by sharp blows, while tough varieties are shaped by pecking, or bruising, and grinding. The bone implement (No. 3) is used in removing small flakes or chips by pressure (see result in No. 4, series 1, and No. 5, series 2). Drills (Nos. 6, 7) are employed in perforating or in deep cutting. The core made by the copper tubular drill is shown in lower figure 7. Abrading stones (No. 5) serve to rub down surfaces and sharpen edges, and chisels (No. 9) are employed in carving soft varieties of stone, as soapstone, shown in lower figure 9. The shaping instruments of advanced peoples are of metal (No. 10), but are extremely simple, save where a machine is used as the motive power.

No. 1. Hammerstones made of boulders and used in flaking stone. Stone Age. Europe and America furnish identical forms---------- 231,866, 231,865

No. 2. Hammerstone, artificial shape. Used in flaking and pecking stone; Stone Age. Europe and America furnish identical forms------ 172,758

No. 3. Implement of bone used in flaking stone by pressure. Alaskan Eskimos -- 176,549

No. 4. Pitted hammer used in flaking and pecking stone; Stone Age. Europe and America furnish identical forms------------------------- 131,526

No. 5. Abrading stone; Stone Age. Europe; America------------------ 231,881

No. 6. Drill. Section of cane used in boring stone; sand used with drill as cutting agent. American Indians.

No. 7. Tubular drill. Copper and partially drilled stone implement; sand used with drill as cutting agent. American Indians--------- ———, 45,588

No. 8. Sawing tool of slate and specimens of sawed stone. Alaskan Eskimo. 56,666, 44,621

(NOTE.—The modern diamond drill, which works by abrasion by fixed diamond points, would come here.)

No. 9. Stone chisel for cutting soapstone and piece of the shaped stone. American Indians -- 35,480

No. 10. Sculptor's four essential tools: (*a*) Bow drill, (*b*) drove, (*c*) tooth chisel, (*d*) mallet, (*e*) chisel, (*f*) point---------------------- 34,864

(NOTE.—The machines used in cutting stone which are in general use mark the great advance of the stoneworking industry.)

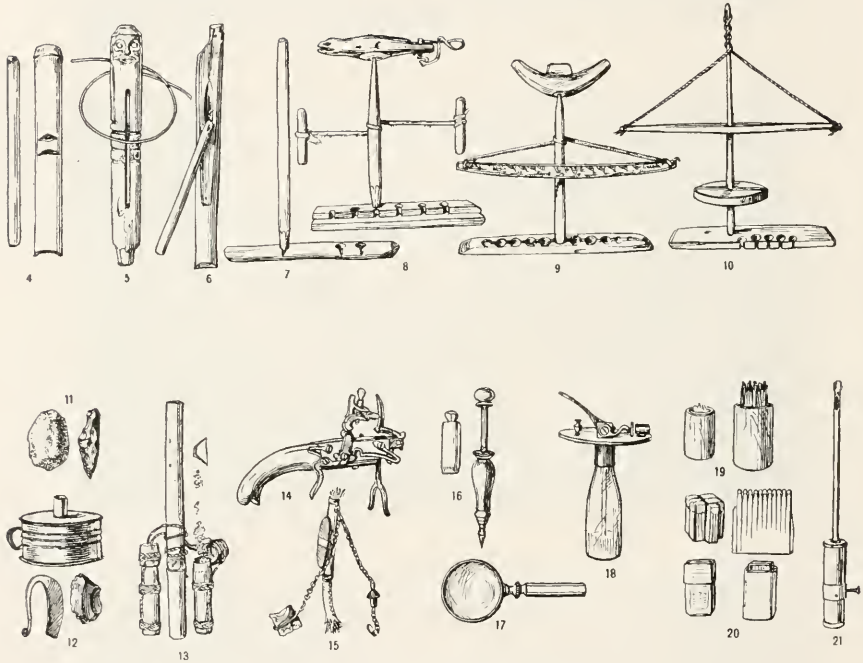
1

2

3

HISTORY OF FIRE MAKING.

FOR EXPLANATION OF PLATE SEE PAGE 3

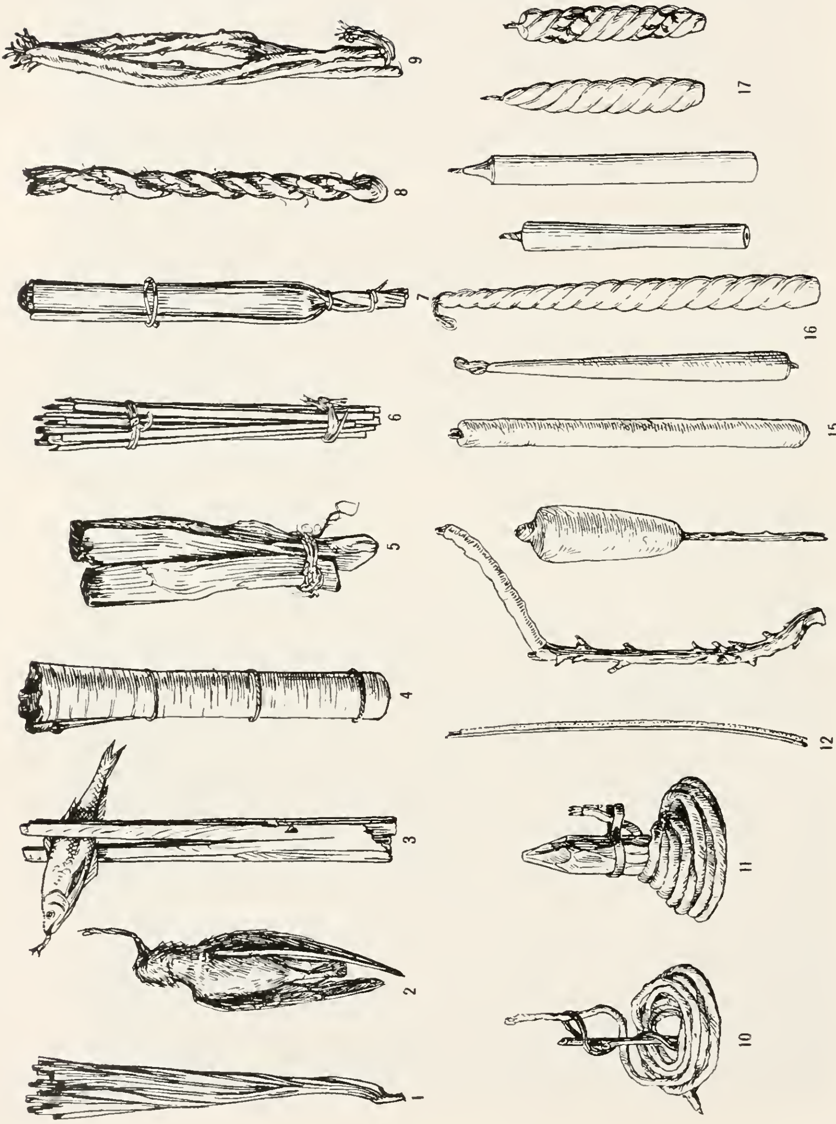


HISTORY OF FIRE-MAKING TOOLS.

FOR EXPLANATION OF PLATE SEE PAGE 3.

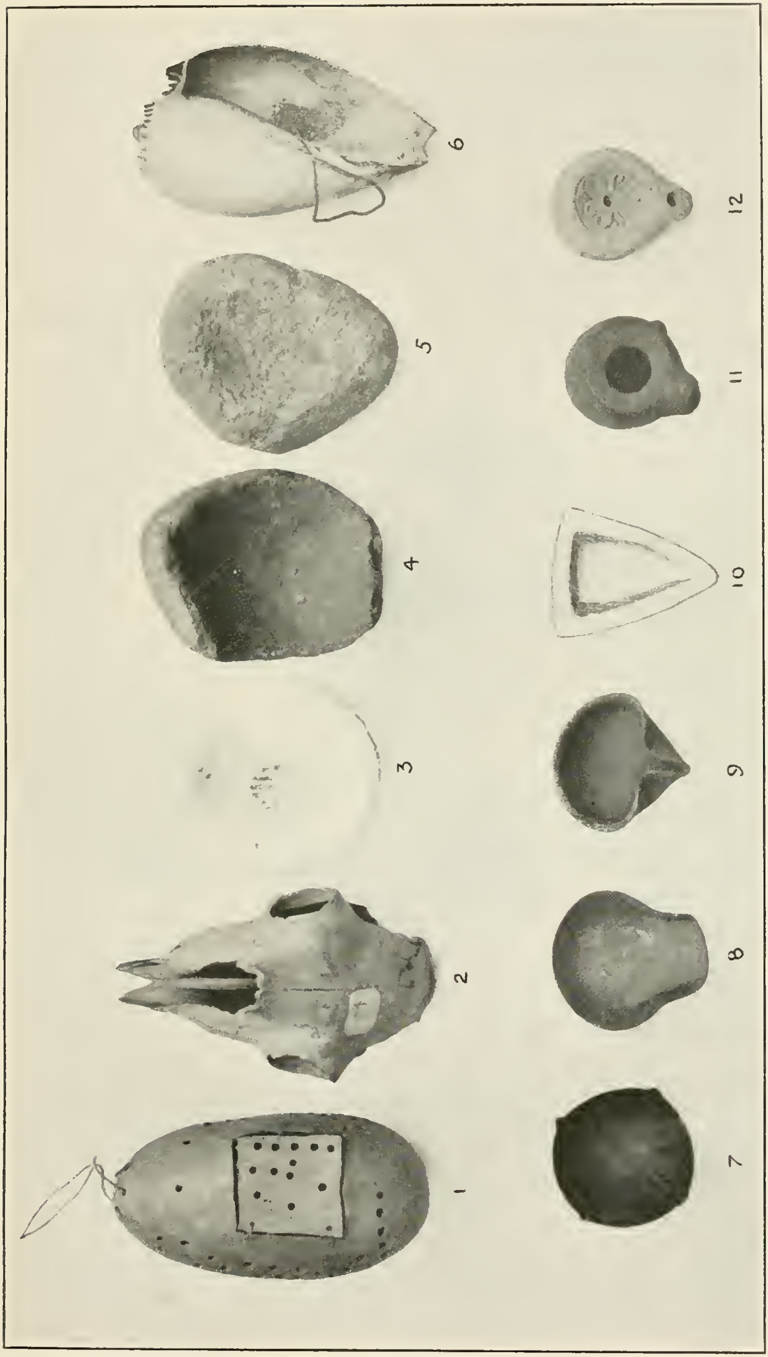
MAKING FIRE BY FRICTION.

FOR EXPLANATION OF PLATE SEE PAGE 5



HISTORY OF TORCH AND CANDLE.

FOR EXPLANATION OF PLATE SEE PAGE 5.



HISTORY OF LAMP.

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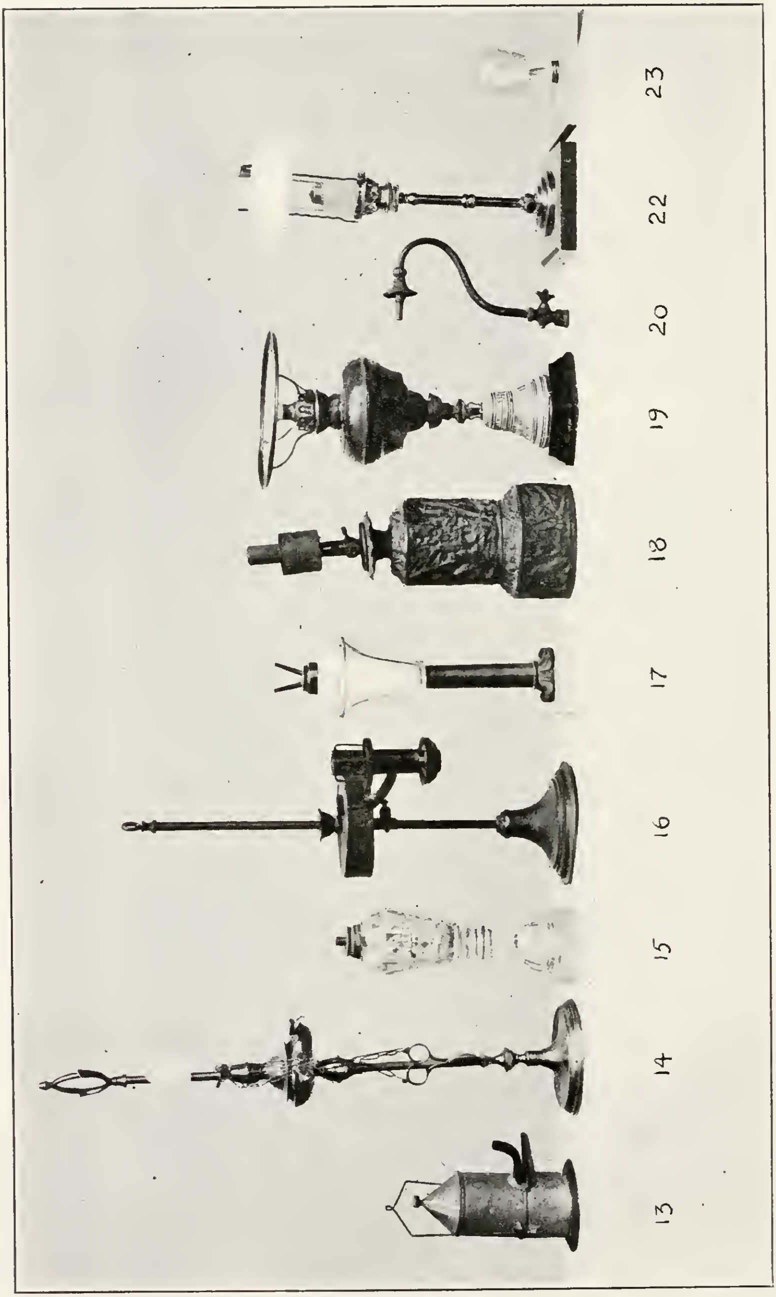
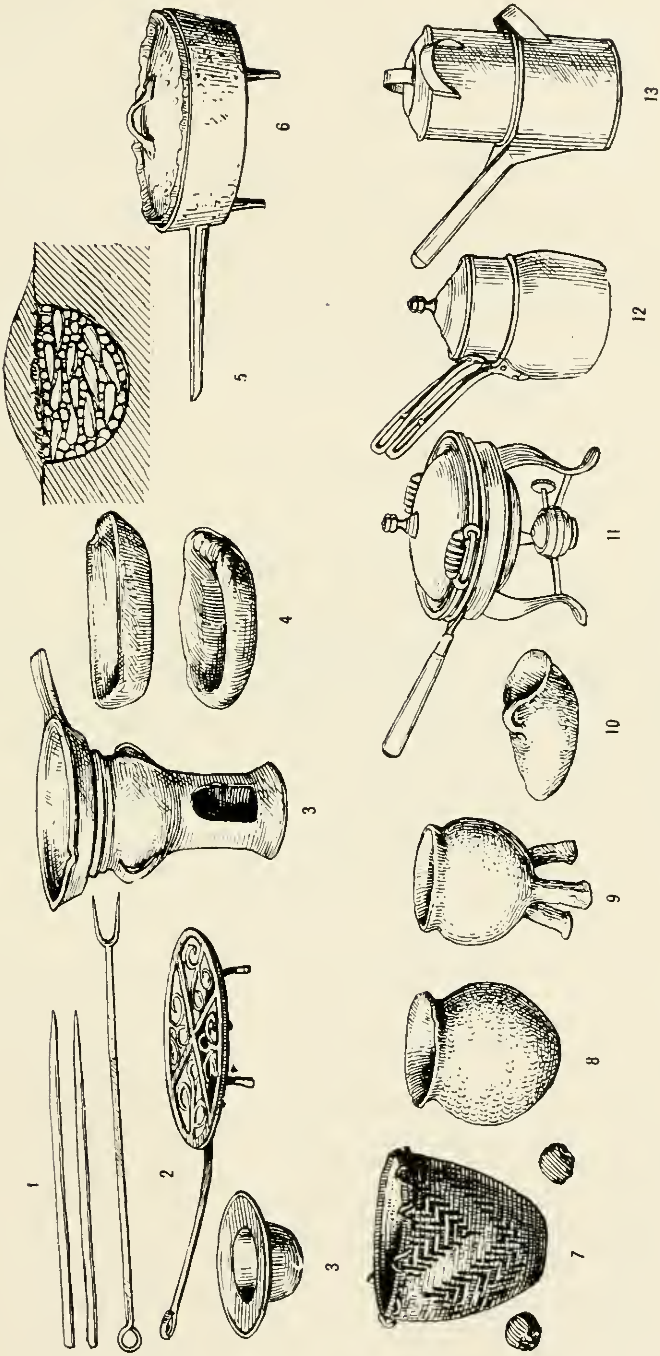


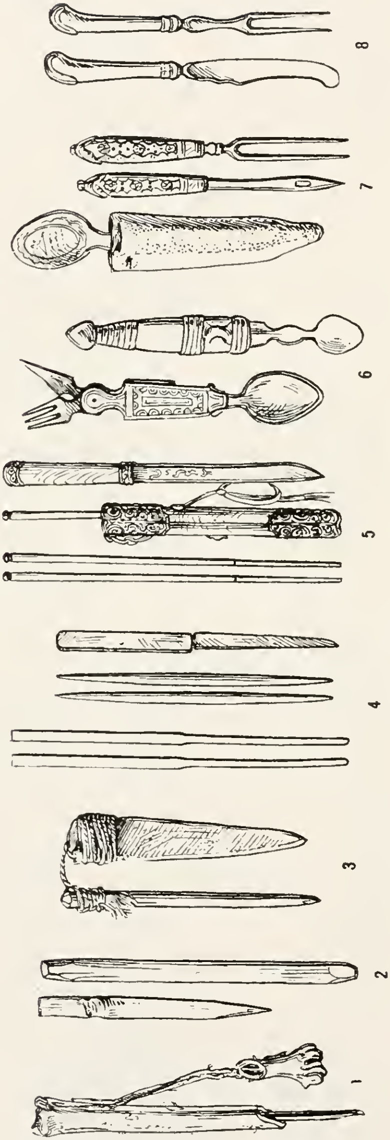
HISTORY OF LAMP—CONTINUED.

FOR EXPLANATION OF PLATE SEE PAGE 6.



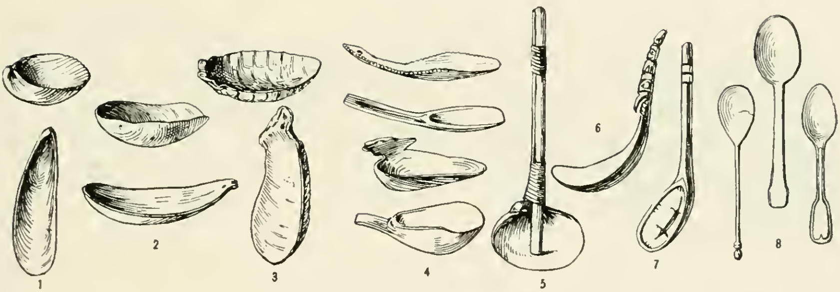
HISTORY OF COOKING UTENSILS.

FOR EXPLANATION OF PLATE SEE PAGE 7



HISTORY OF KNIFE AND FORK.

FOR EXPLANATION OF PLATE SEE PAGE 8.

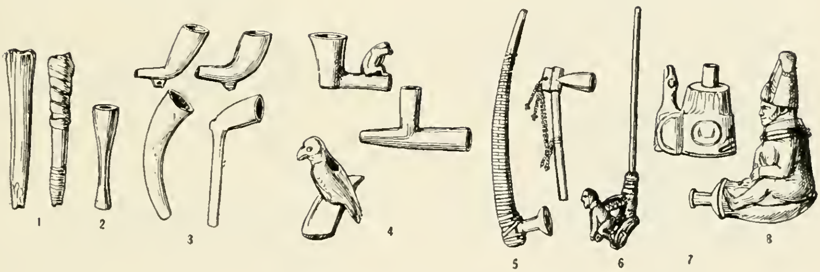


HISTORY OF SPOON.

FOR EXPLANATION OF PLATE SEE PAGE 9.

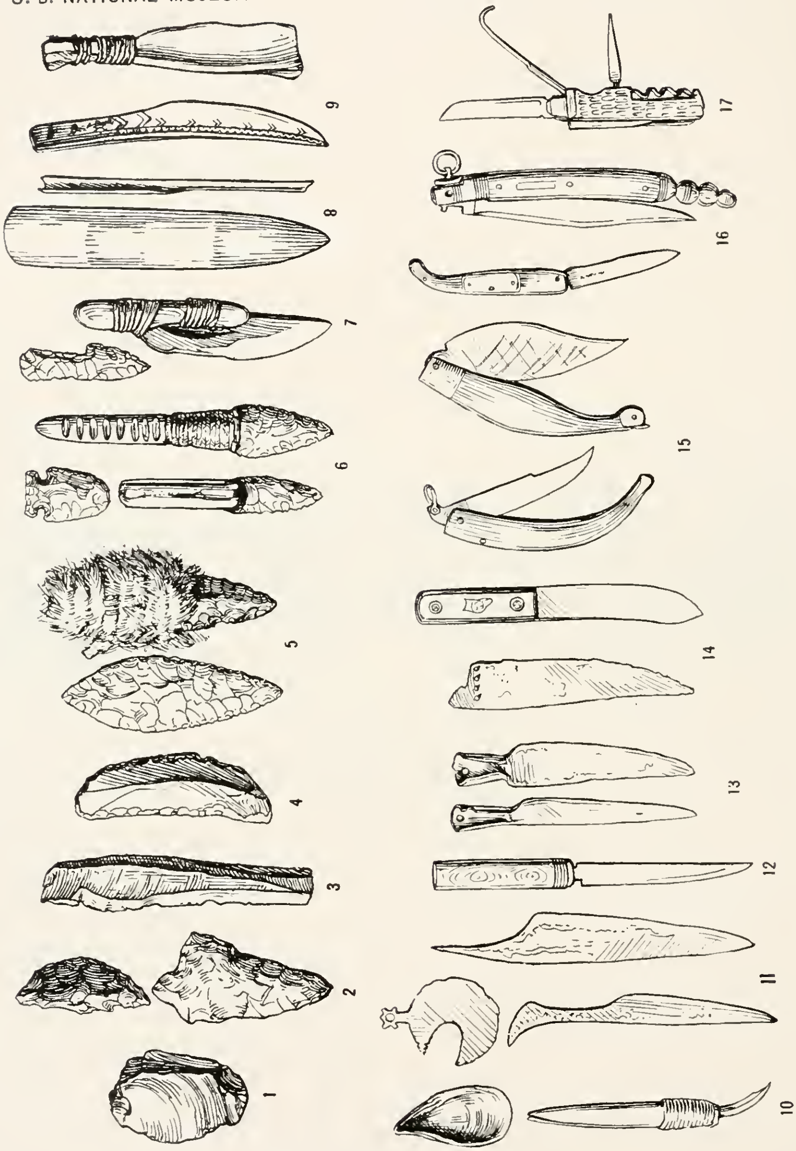
HISTORY OF CUP.

FOR EXPLANATION OF PLATE SEE PAGE 10.



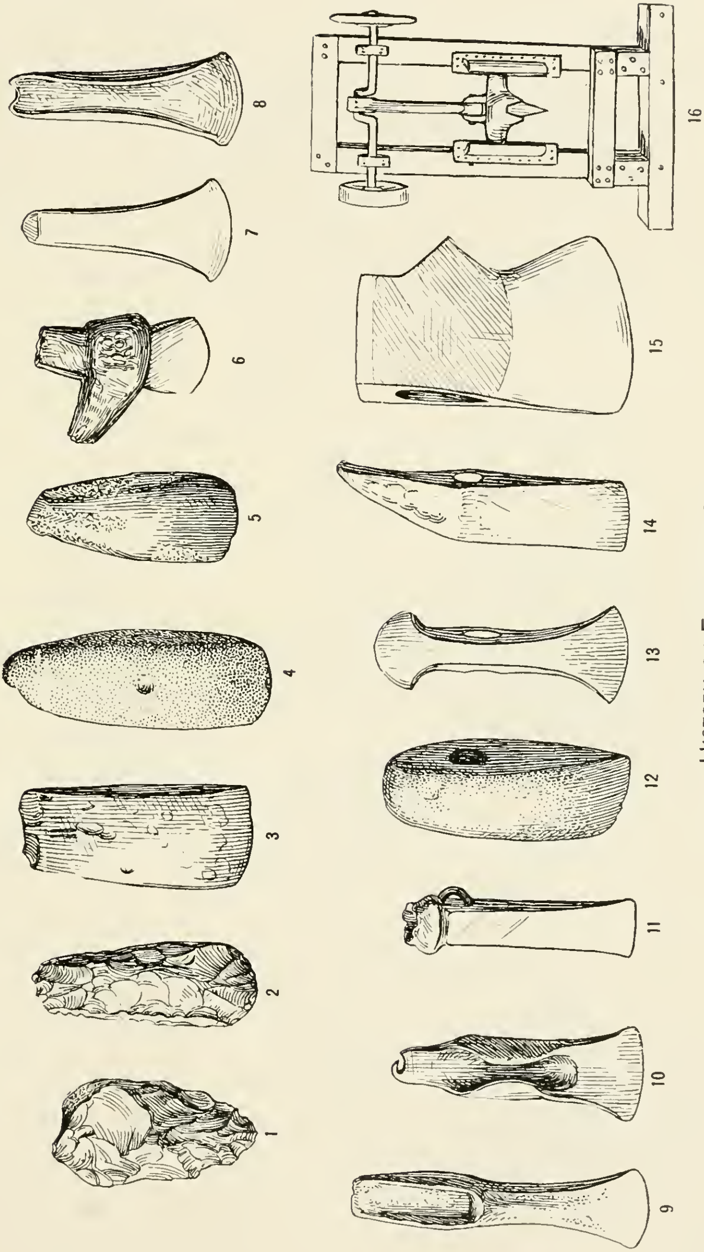
HISTORY OF TOBACCO PIPE.

FOR EXPLANATION OF PLATE SEE PAGE 10.



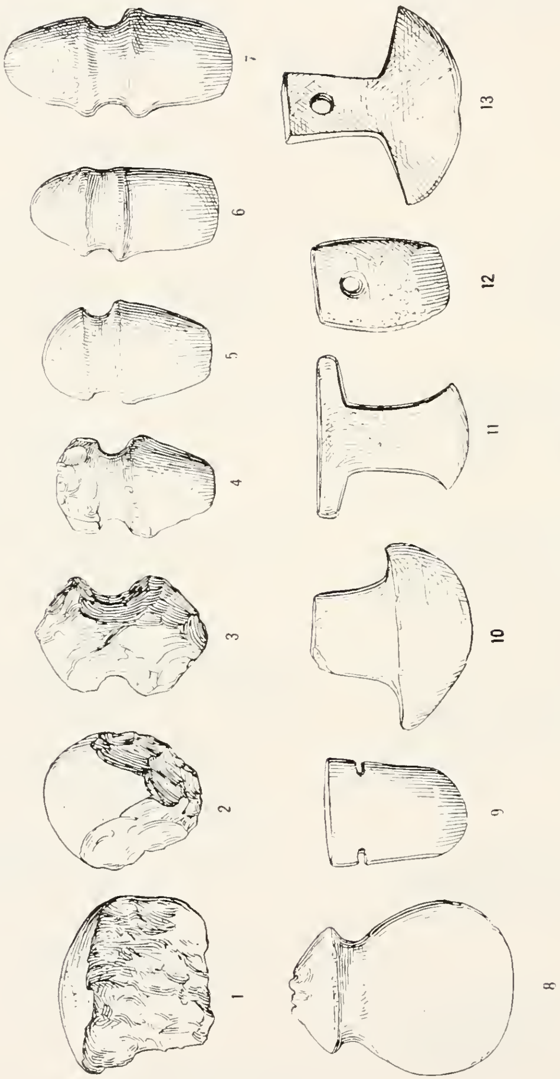
DEVELOPMENT OF JACKKNIFE.

FOR EXPLANATION OF PLATE SEE PAGE 11.



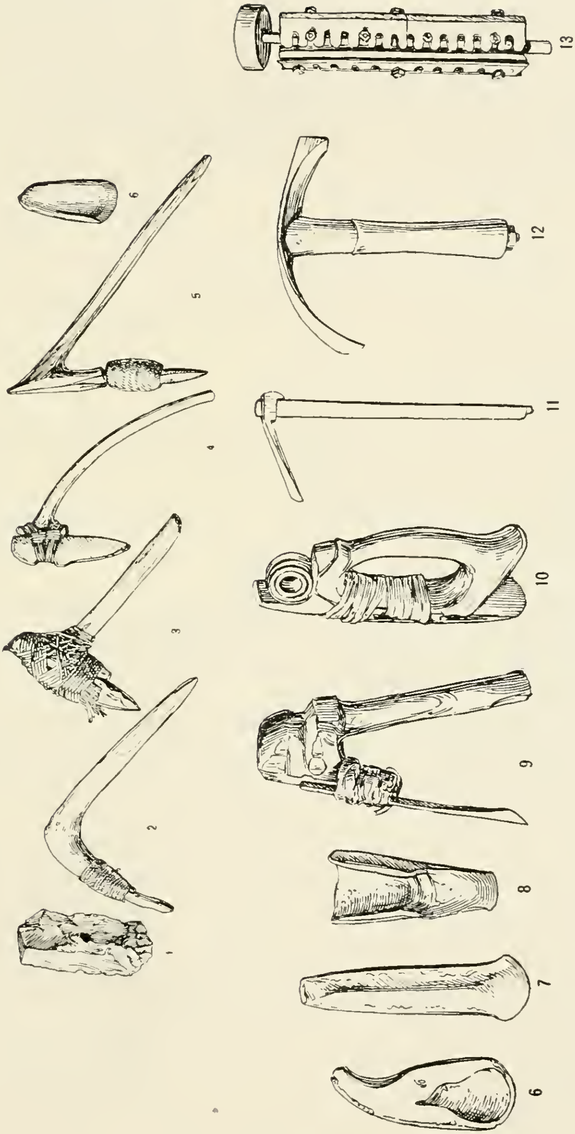
History of European Ax.

For explanation of plate see page 12.



HISTORY OF ABORIGINAL AMERICAN AX.

FOR EXPLANATION OF PLATE SEE PAGE 13.



HISTORY OF ADZ.

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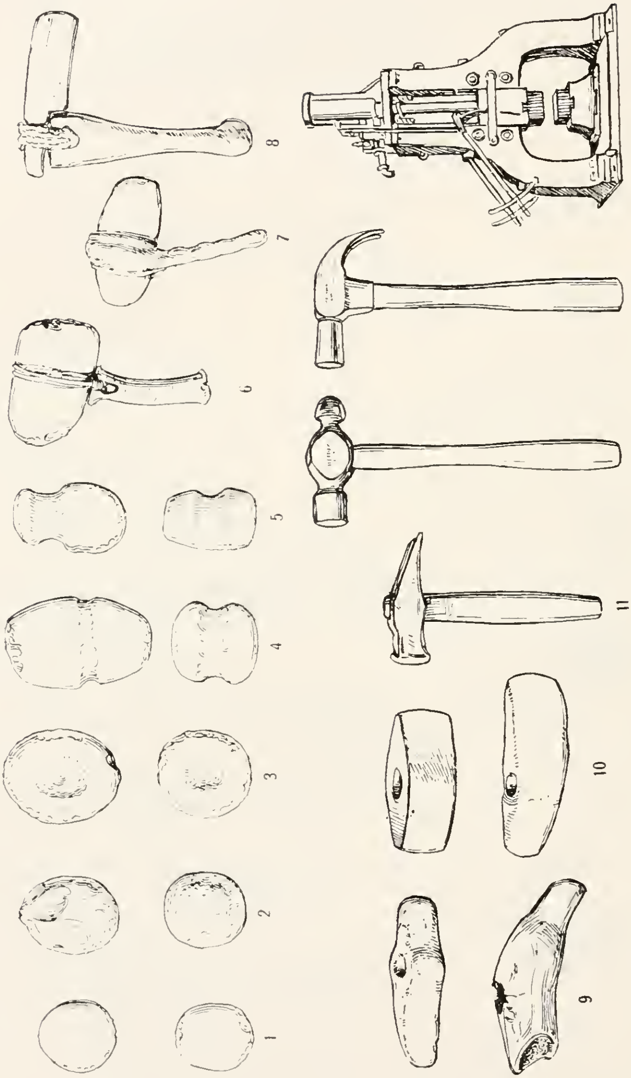
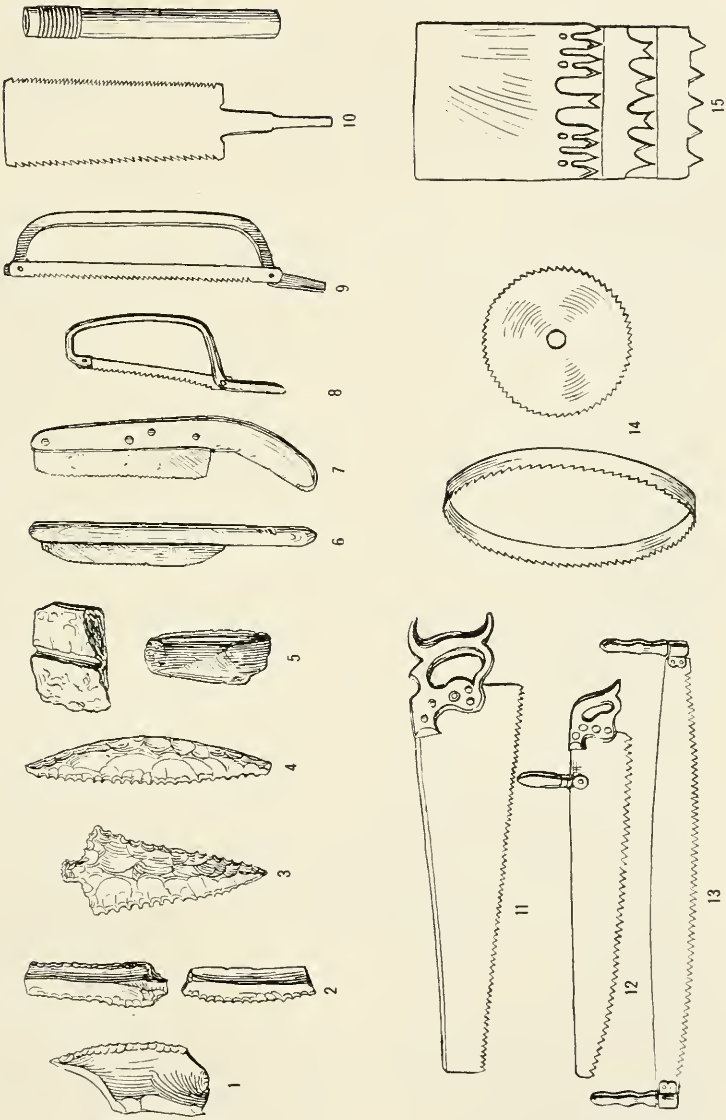


History of Hammer.

For explanation of plate see page 15.



HISTORY OF SAW.

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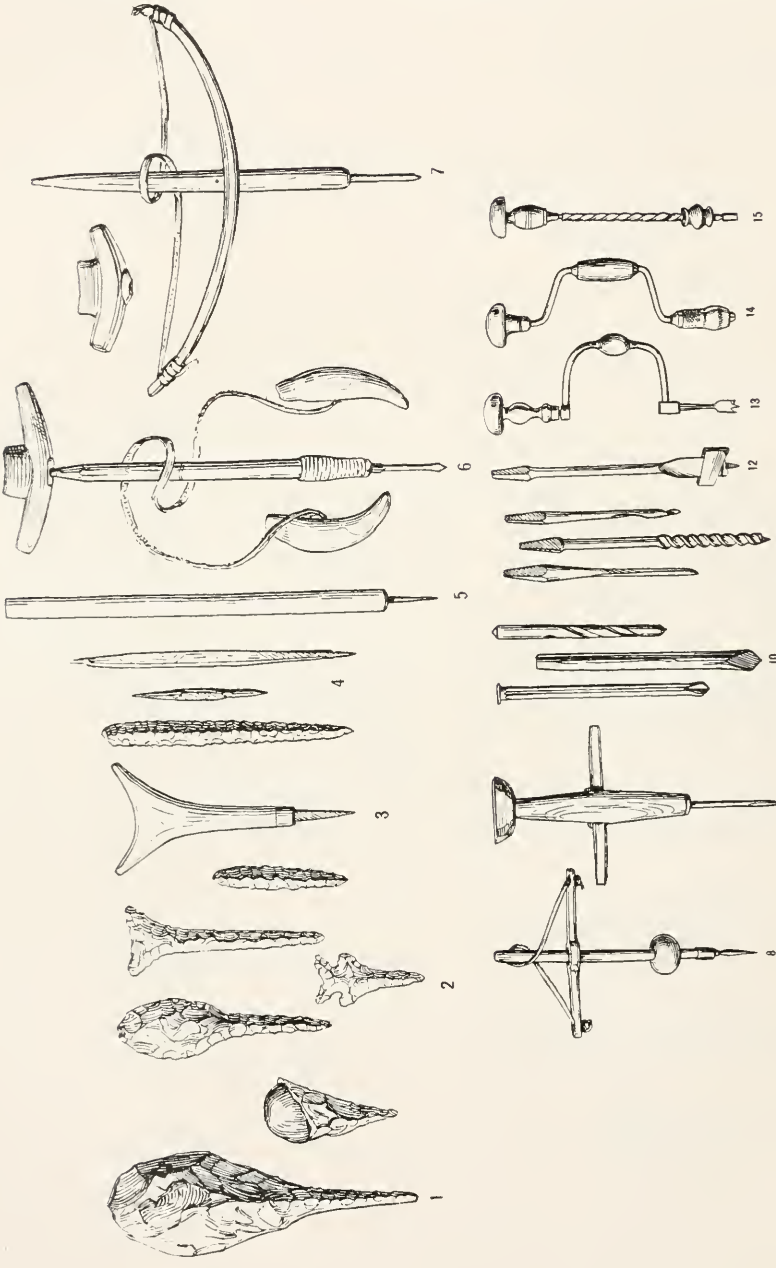
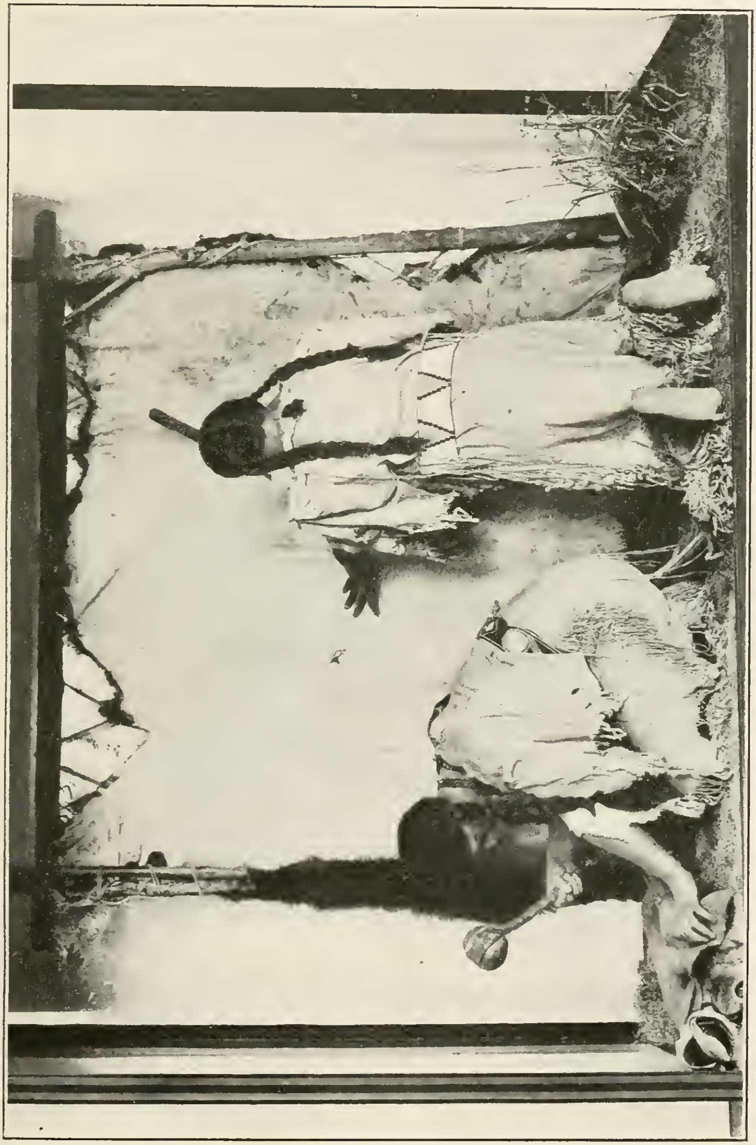


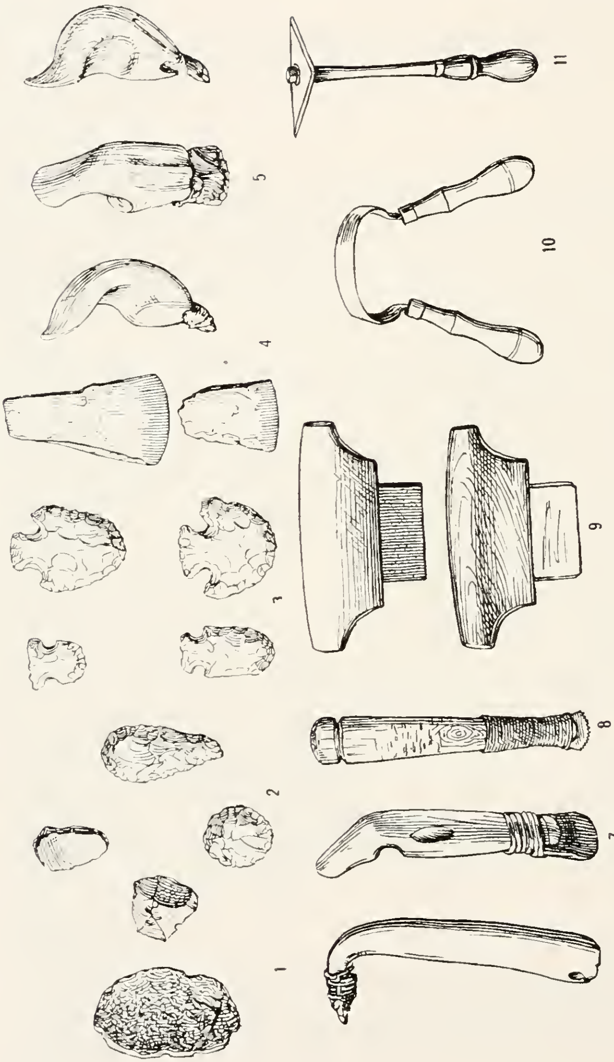
HISTORY OF DRILL.

FOR EXPLANATION OF PLATE SEE PAGE 17.



Indian Women Dressing Hides.

For explanation of plate see page 19



HISTORY OF SCRAPER.

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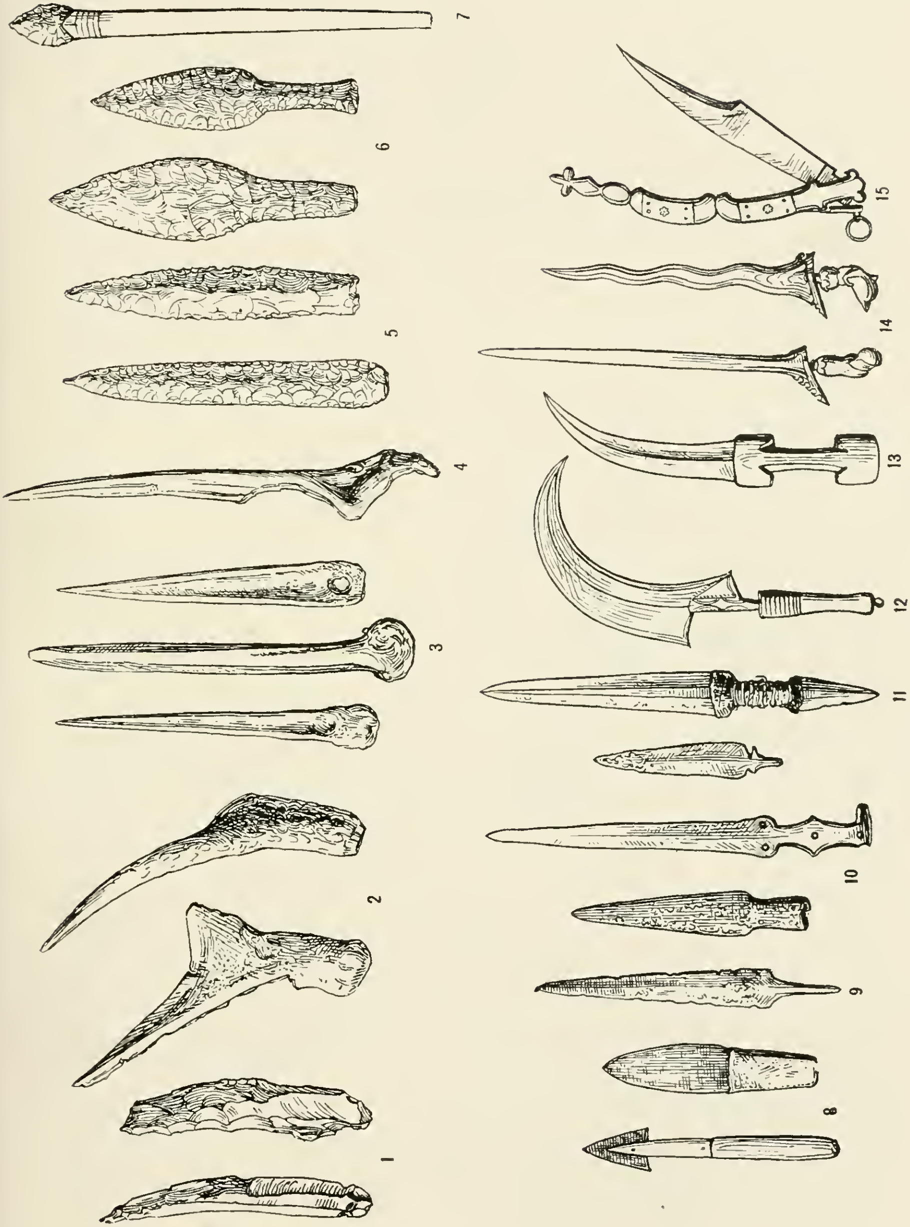
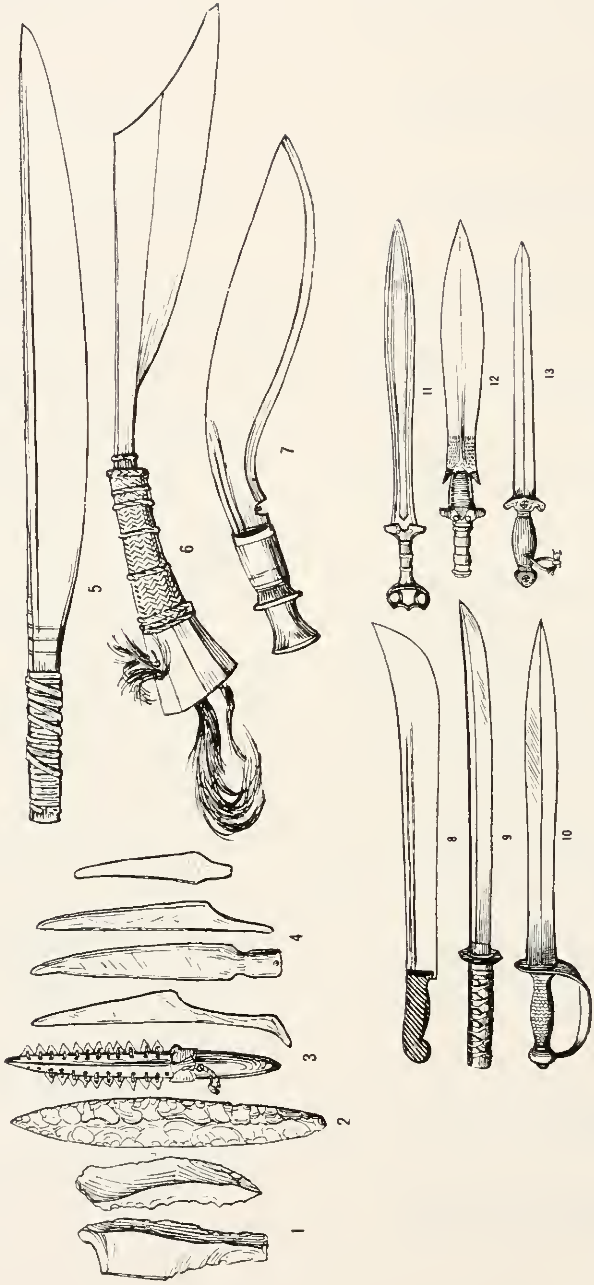


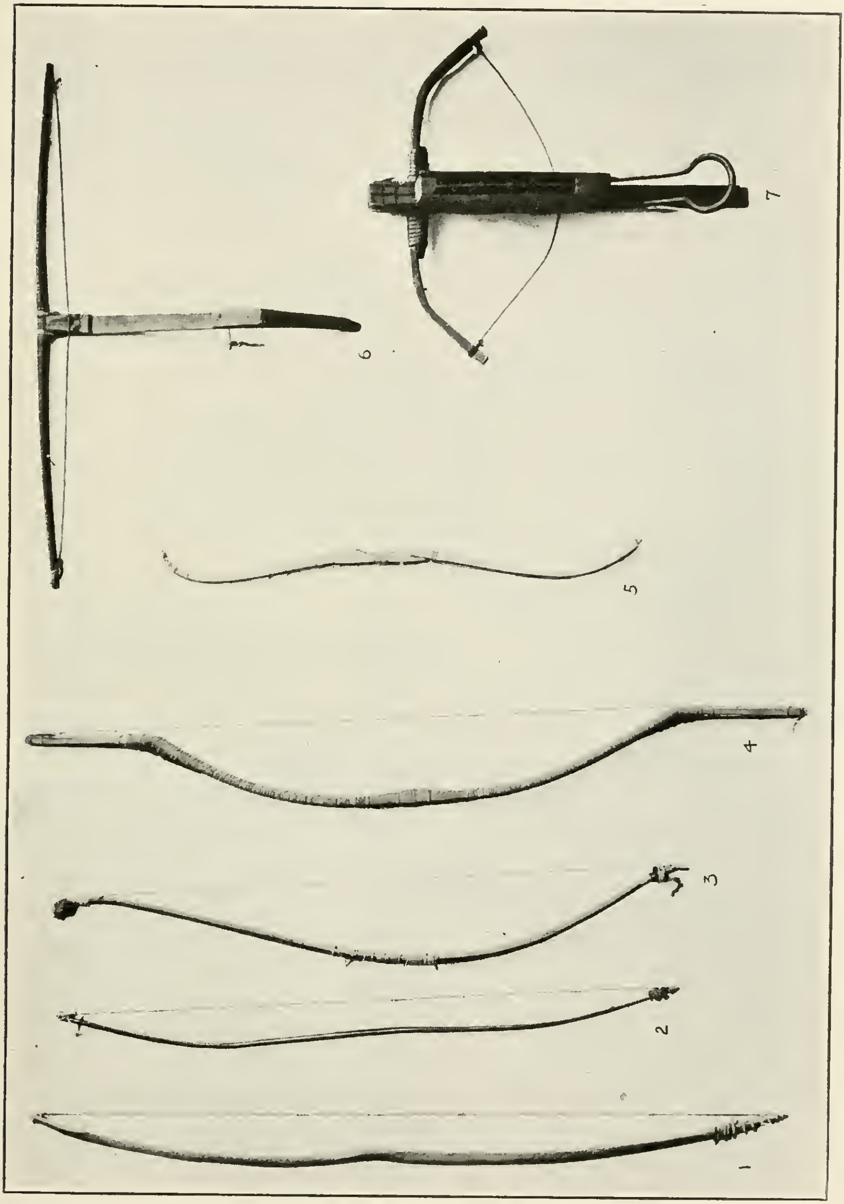
HISTORY OF WEAPONS FOR STABBING.

FOR EXPLANATION OF PLATE SEE PAGE 20



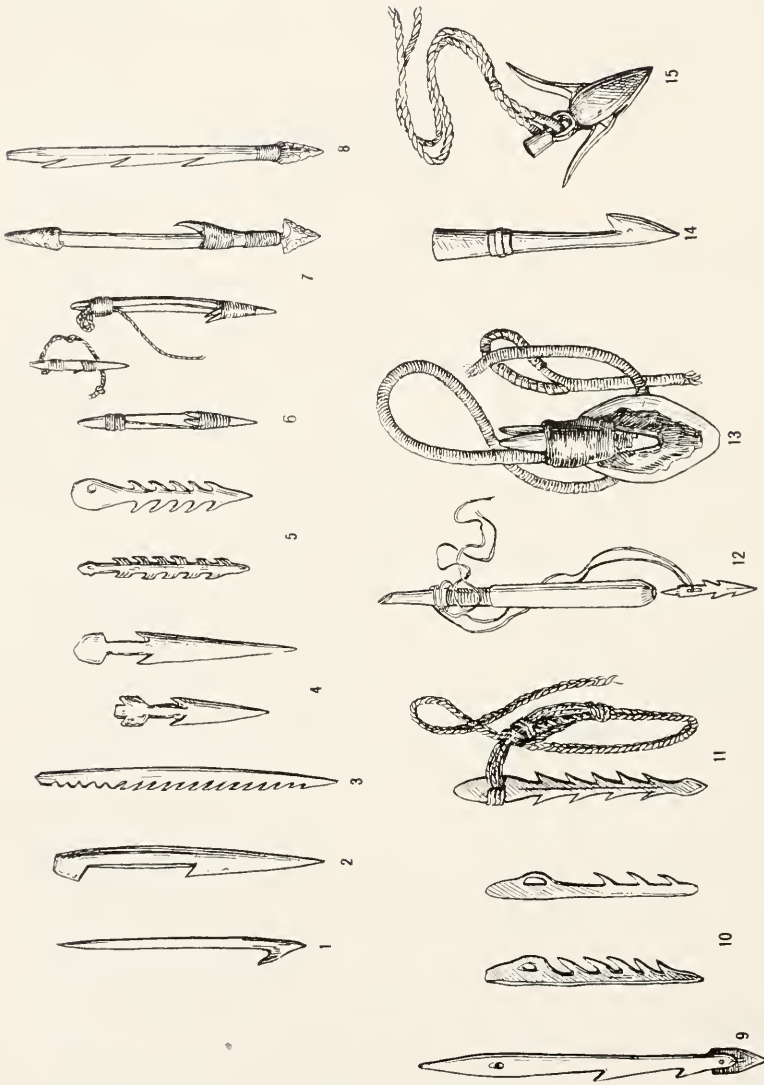
History of Weapons for Cutting and Thrusting.

For explanation of plate see page 21.



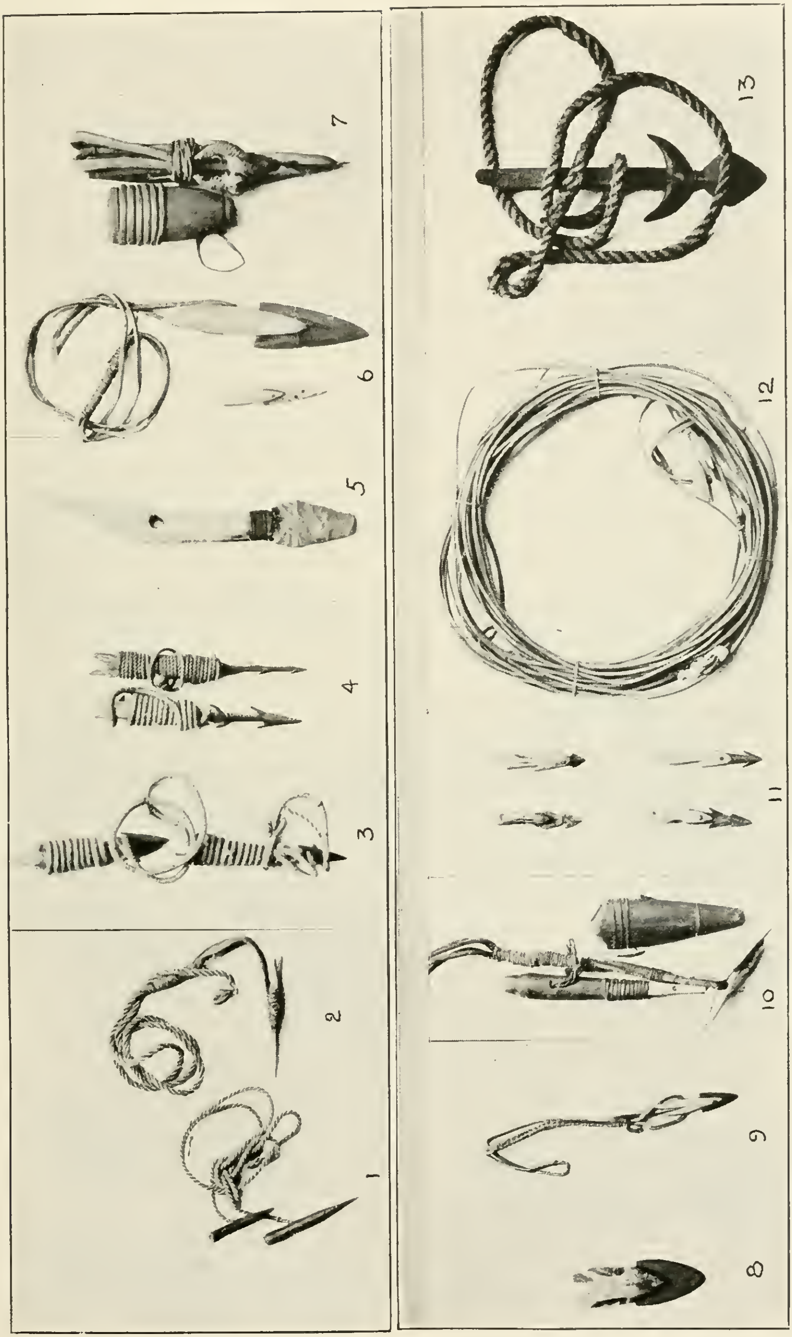
HISTORY OF BOW AND ARBALEST.

FOR EXPLANATION OF PLATE SEE PAGE 22.



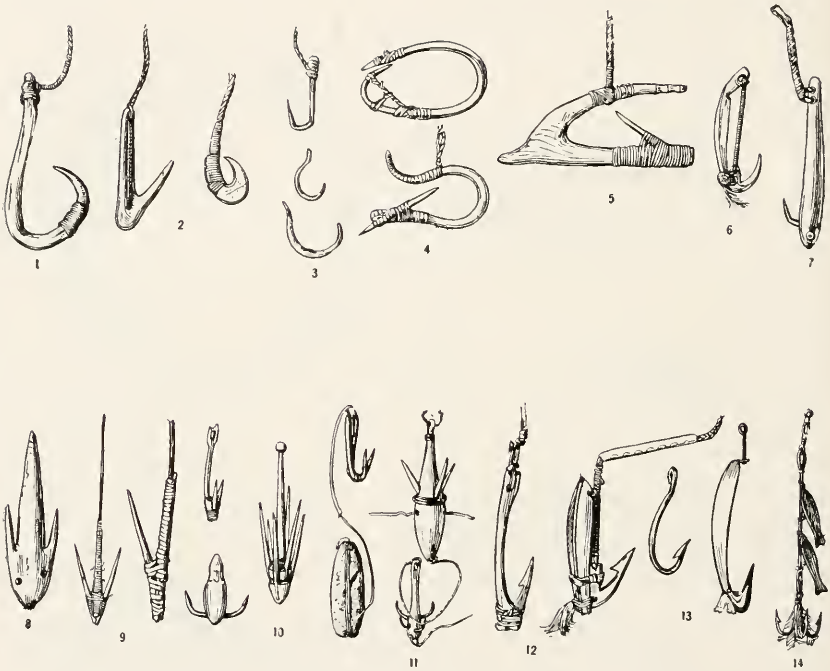
HISTORY OF HARPOON BARB.

FOR EXPLANATION OF PLATE SEE PAGE 24



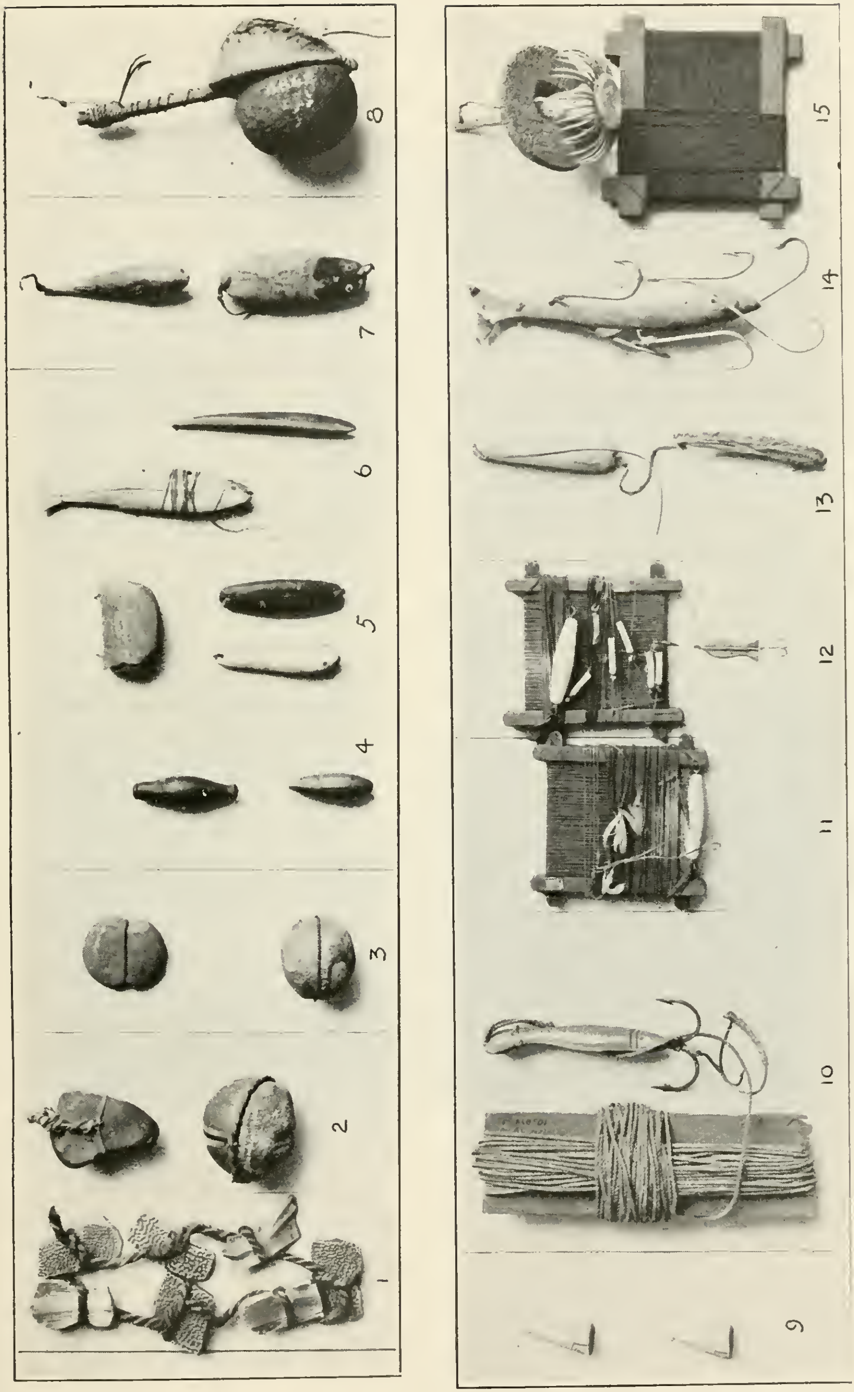
HISTORY OF TOGGLE HARPOONS.

FOR EXPLANATION OF PLATE SEE PAGE 25.



HISTORY OF FISH HOOKS.

FOR EXPLANATION OF PLATE SEE PAGE 27.

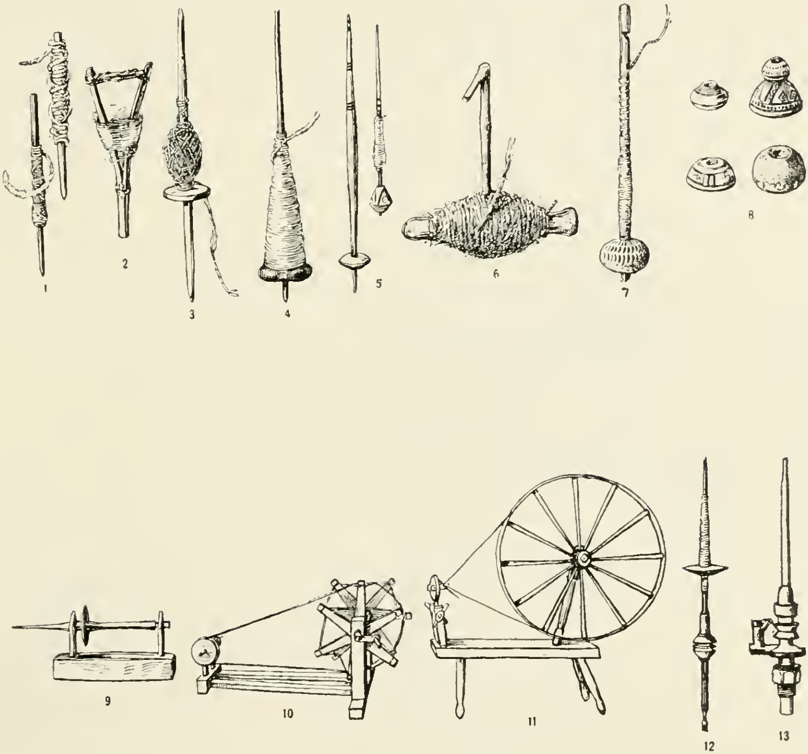


HISTORY OF SINKERS.

FOR EXPLANATION OF PLATE SEE PAGE 28.

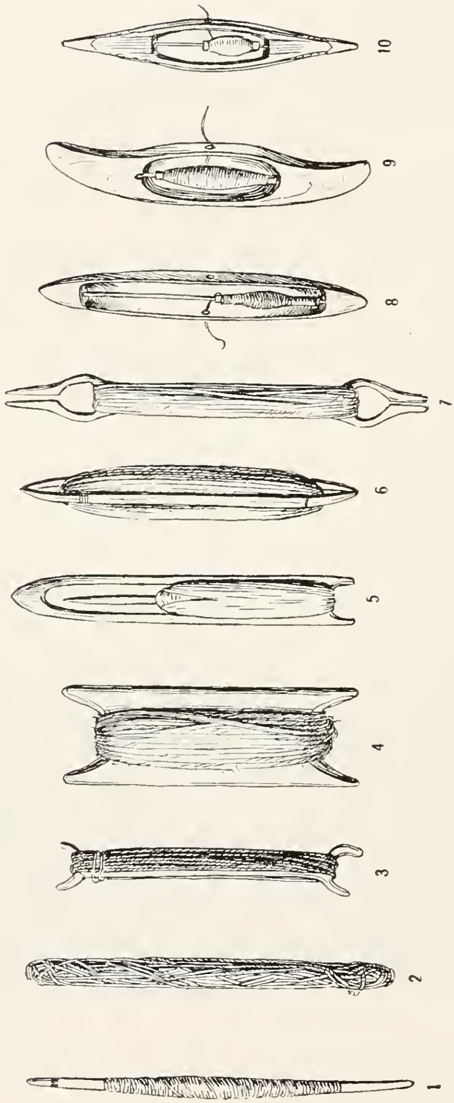
ZUNI INDIAN WEAVER.

FOR EXPLANATION OF PLATE SEE PAGE 29.



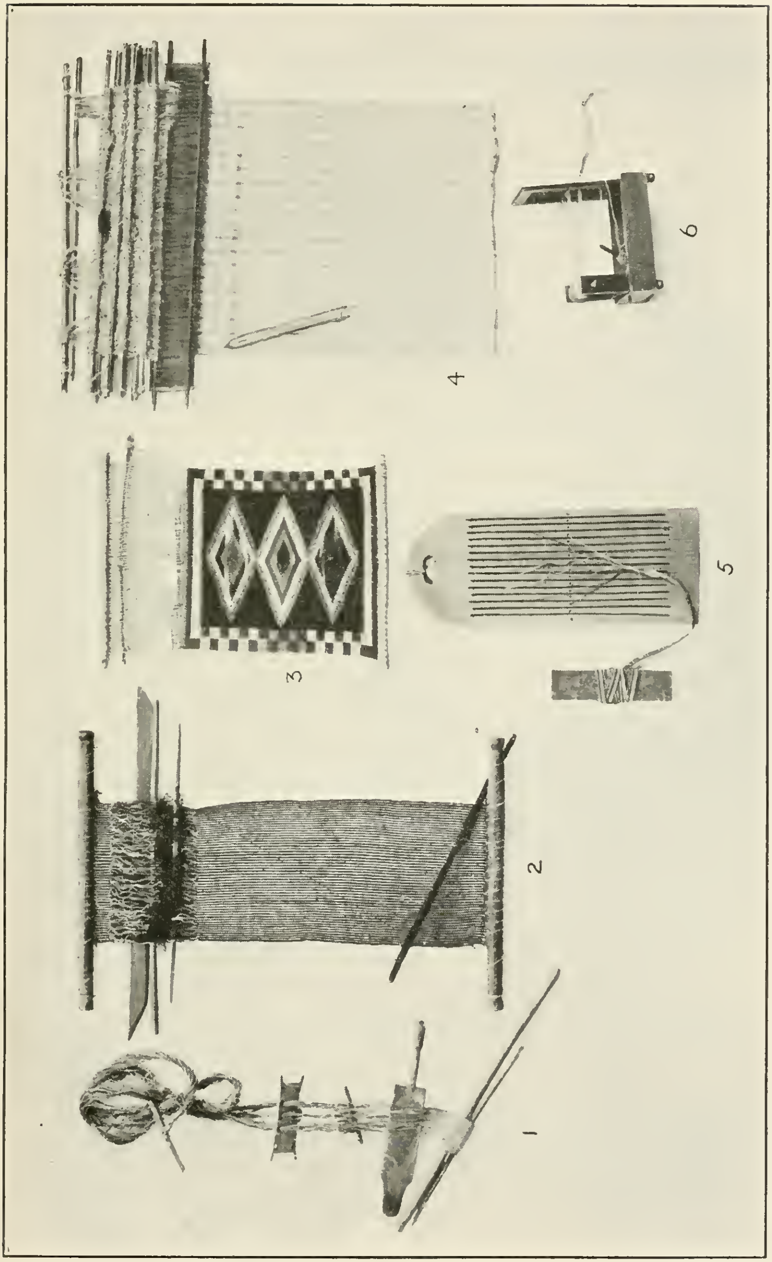
HISTORY OF SPINDLE.

FOR EXPLANATION OF PLATE SEE PAGE 30.



HISTORY OF SHUTTLE.

FOR EXPLANATION OF PLATE SEE PAGE 30.



HISTORY OF LOOM.

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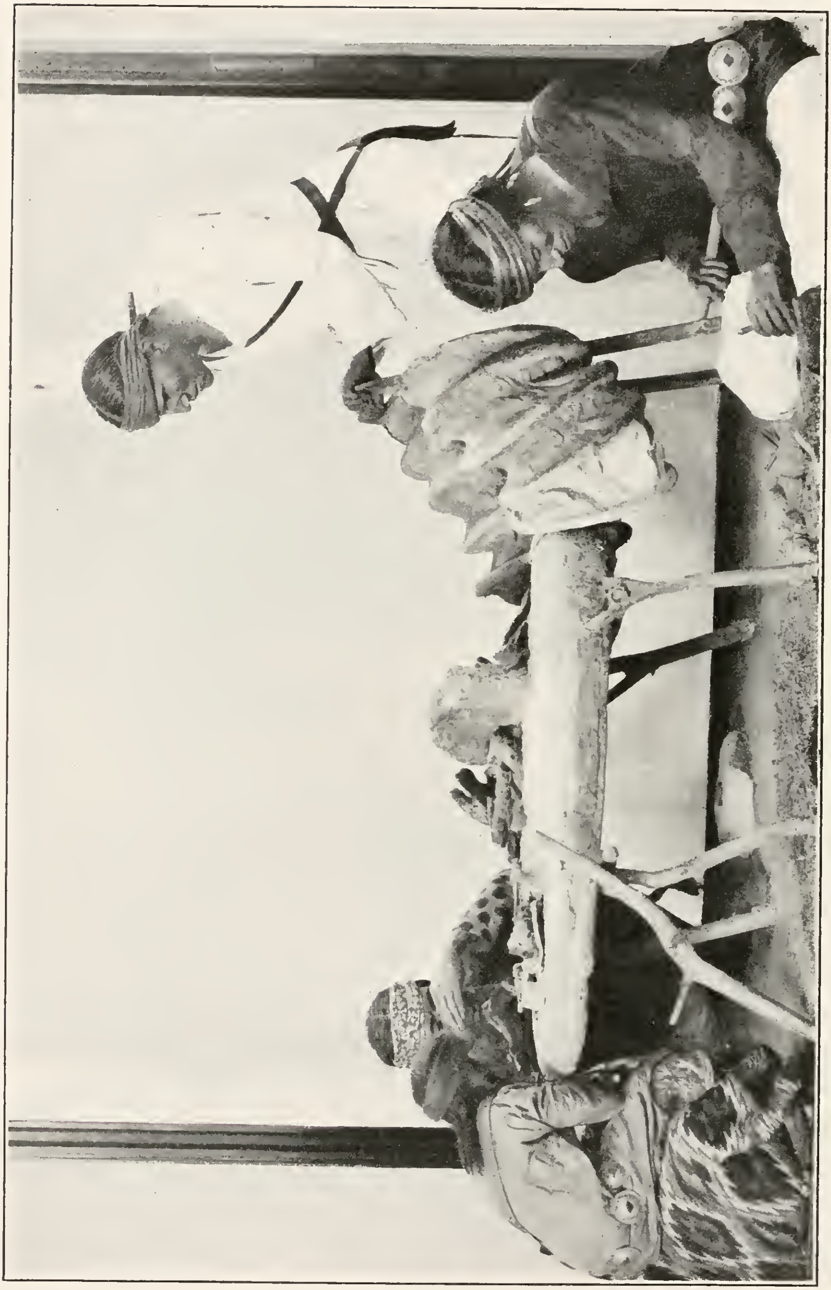

NAVAHO METAL WORKERS

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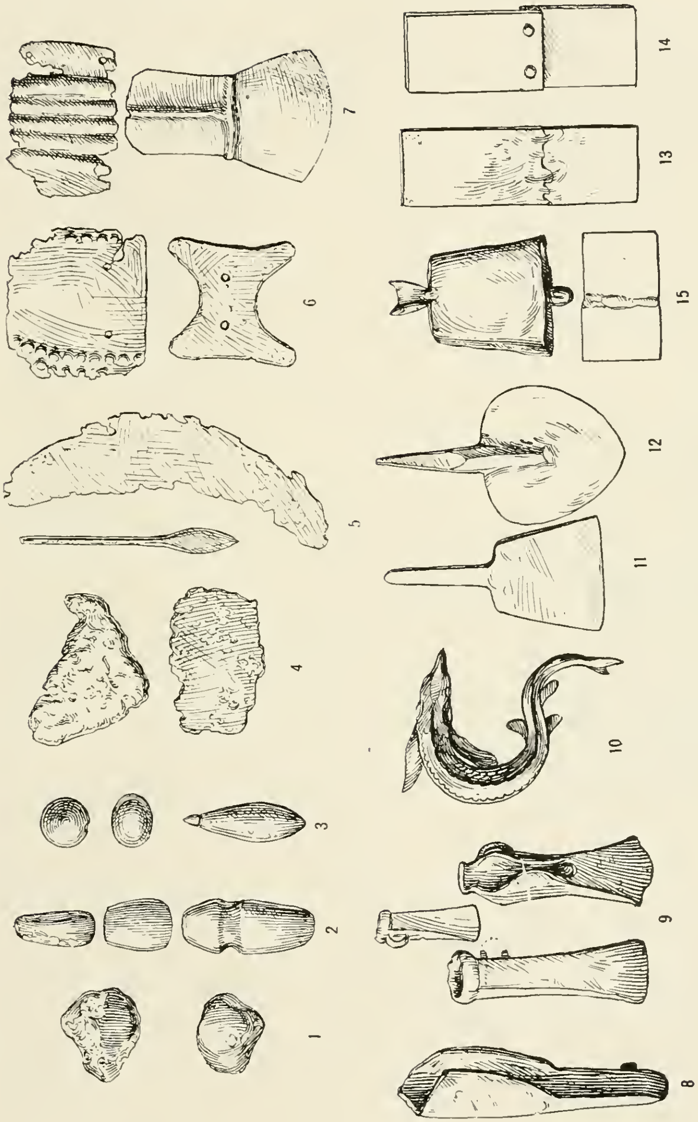

HISTORY OF METALLURGICAL PROCESS.

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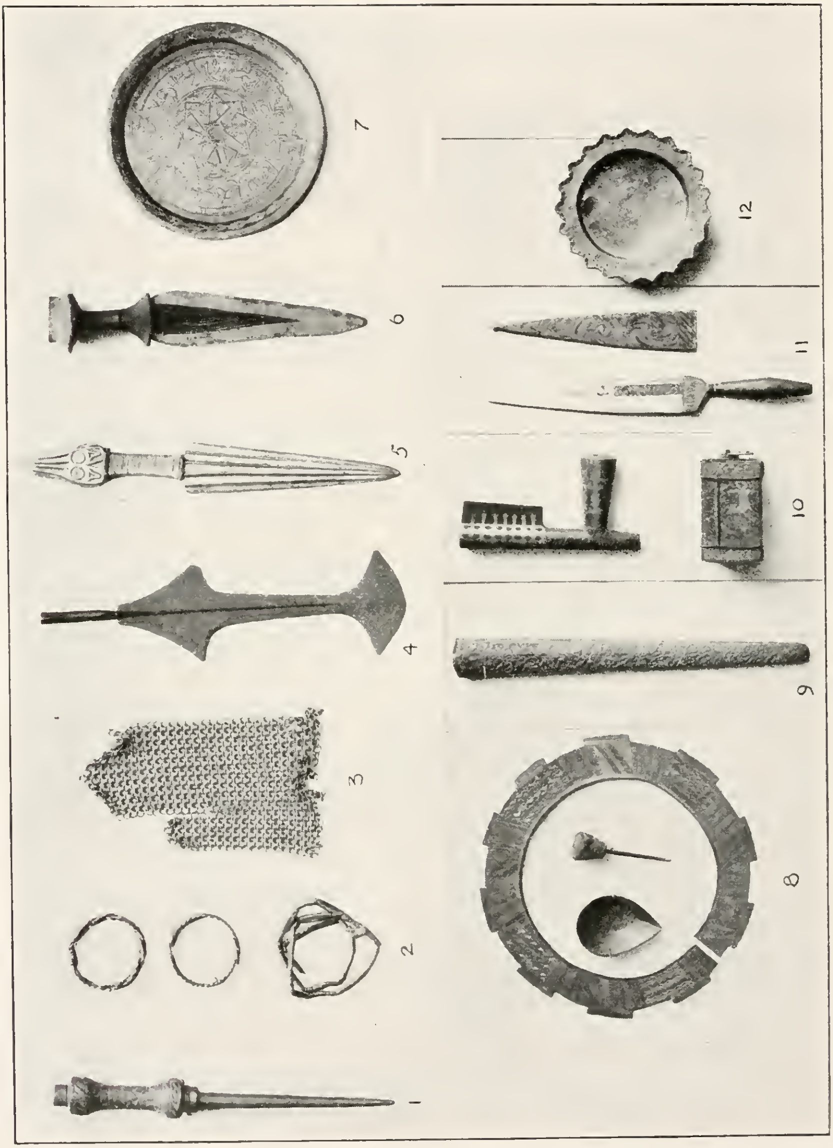

HISTORY OF METAL WORKING.

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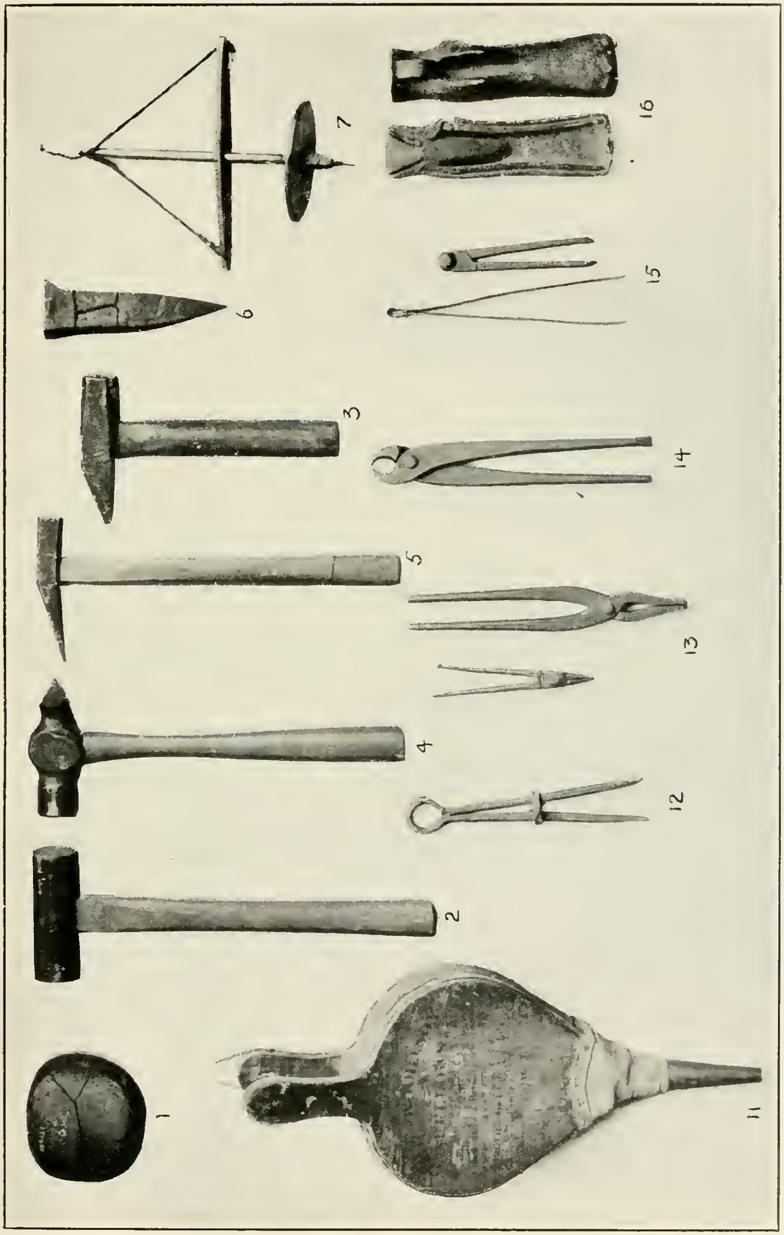
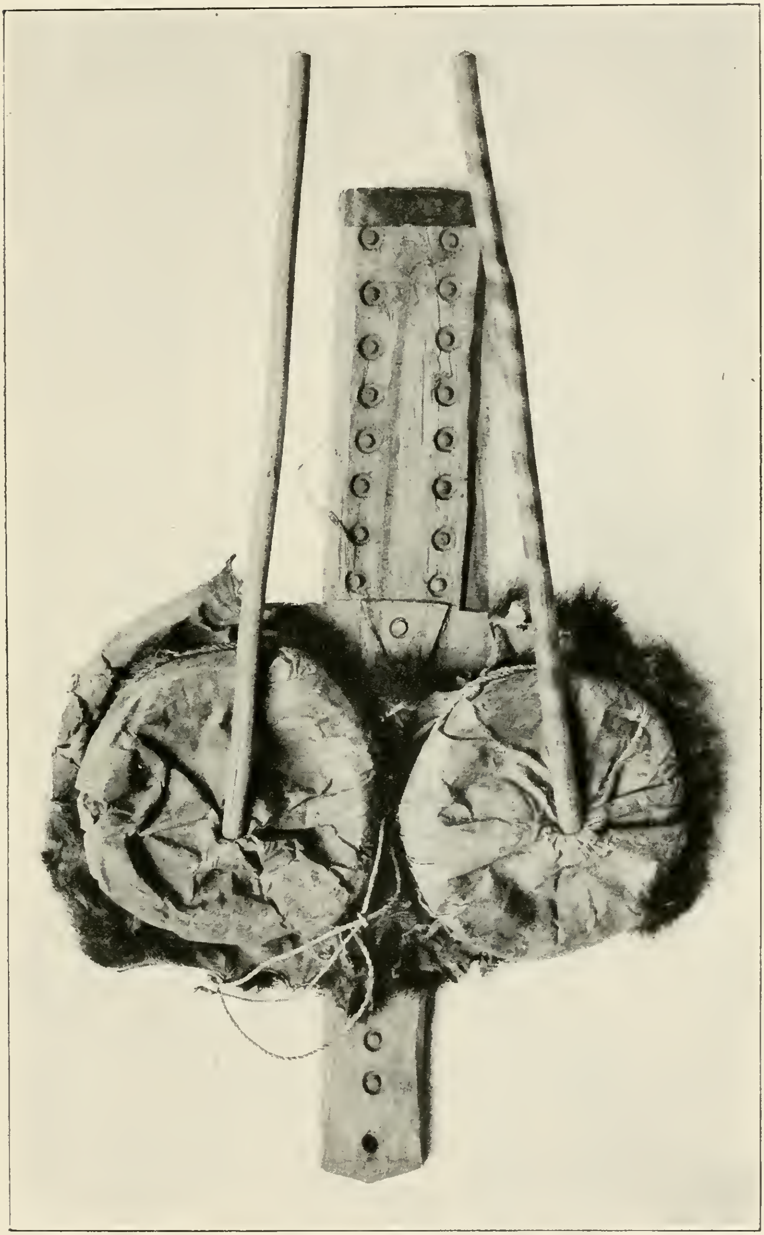


HISTORY OF TOOLS FOR METAL WORKING.

FOR EXPLANATION OF PLATE SEE PAGE 34.

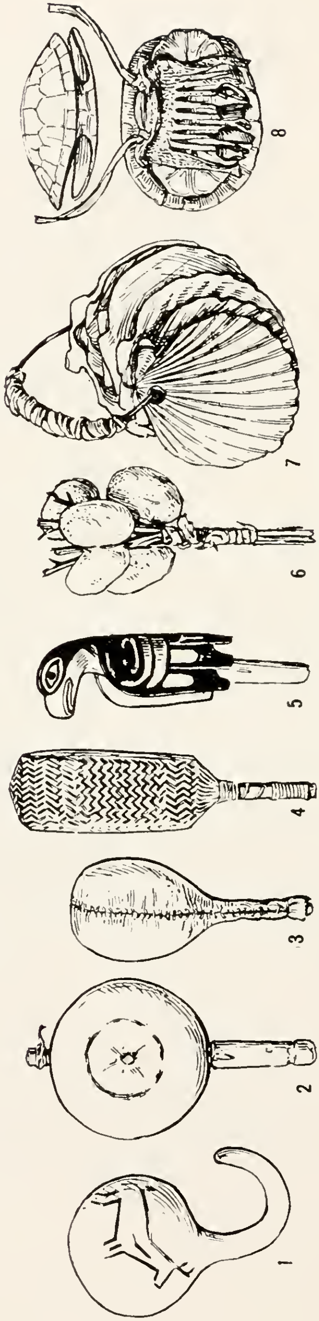
A COUNTRY BLACKSMITH SHOP.

FOR EXPLANATION OF PLATE SEE PAGE 35



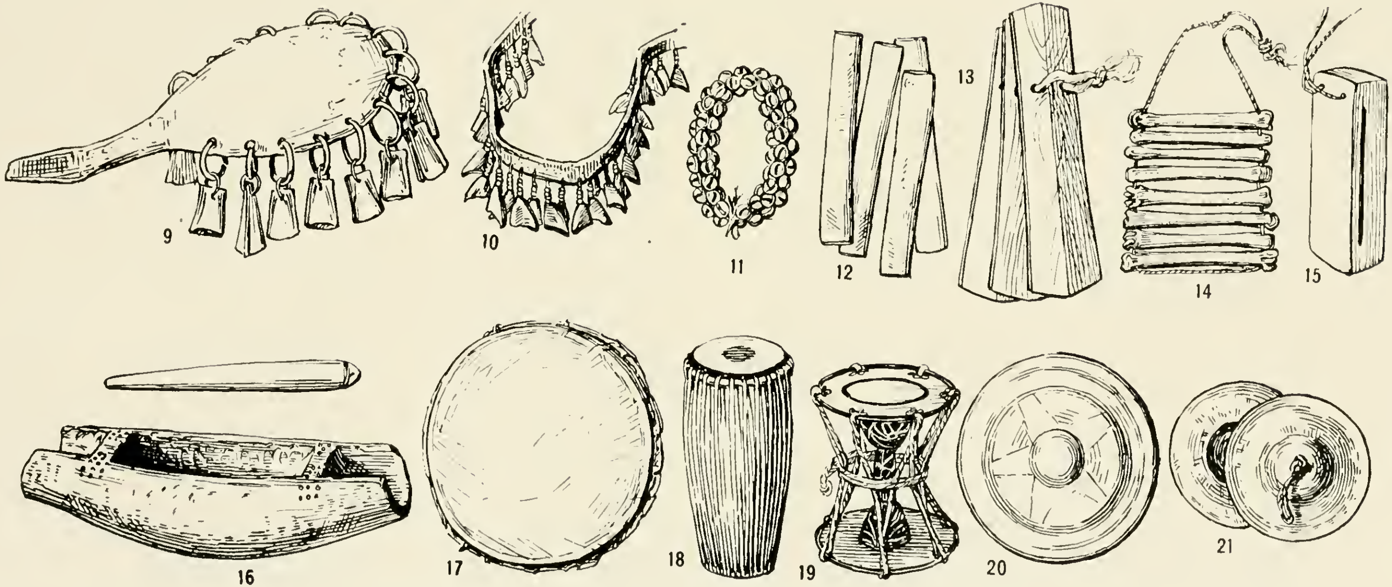
PRIMITIVE FORM OF DOUBLE BELLOWS.

FOR EXPLANATION OF PLATE SEE PAGE 35



HISTORY OF PERCUSSIVE MUSICAL INSTRUMENTS.

FOR EXPLANATION OF PLATE SEE PAGE 35.



HISTORY OF PERCUSSIVE MUSICAL INSTRUMENTS—CONTINUED.

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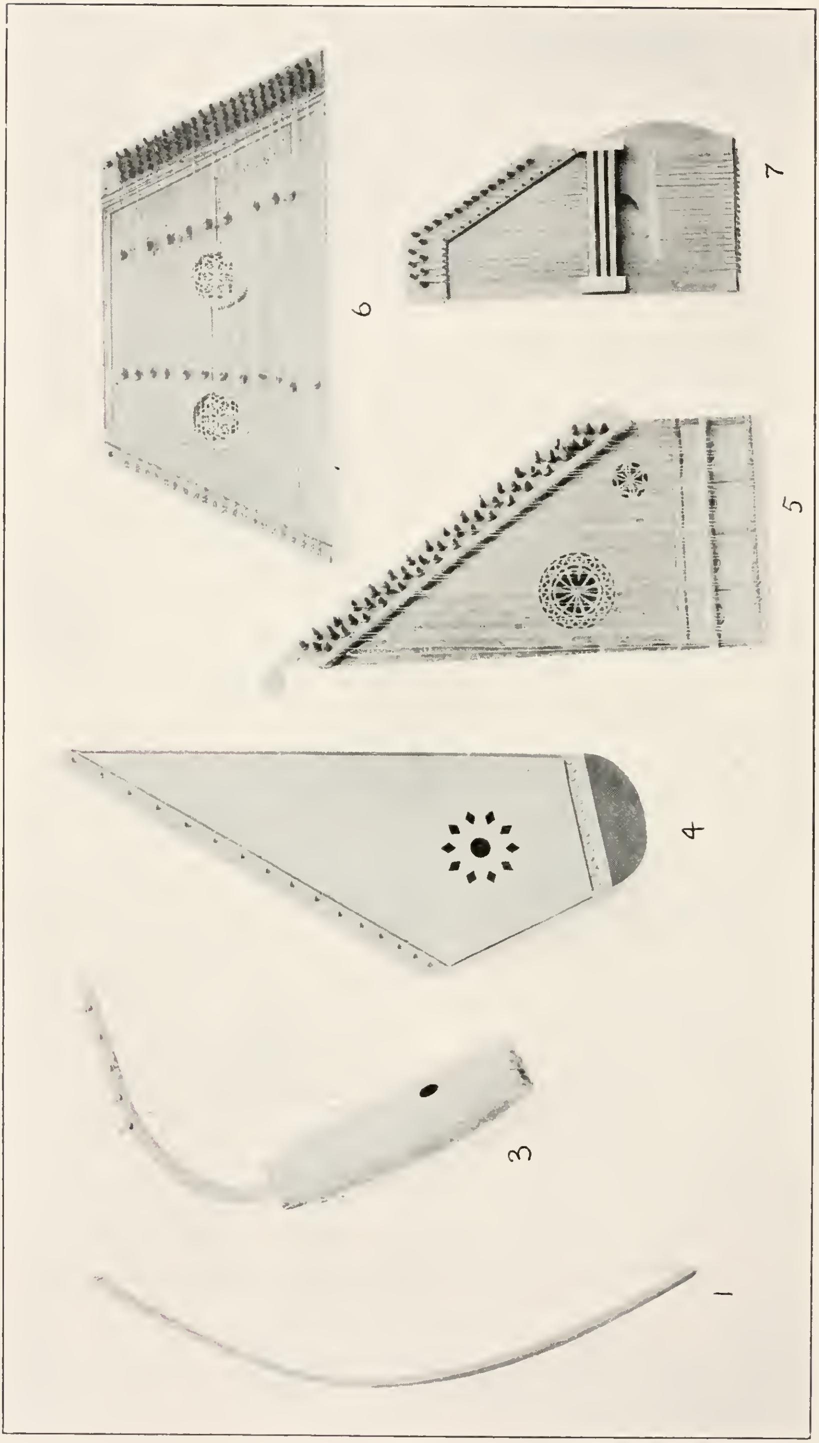


HISTORY OF STRINGED INSTRUMENTS.

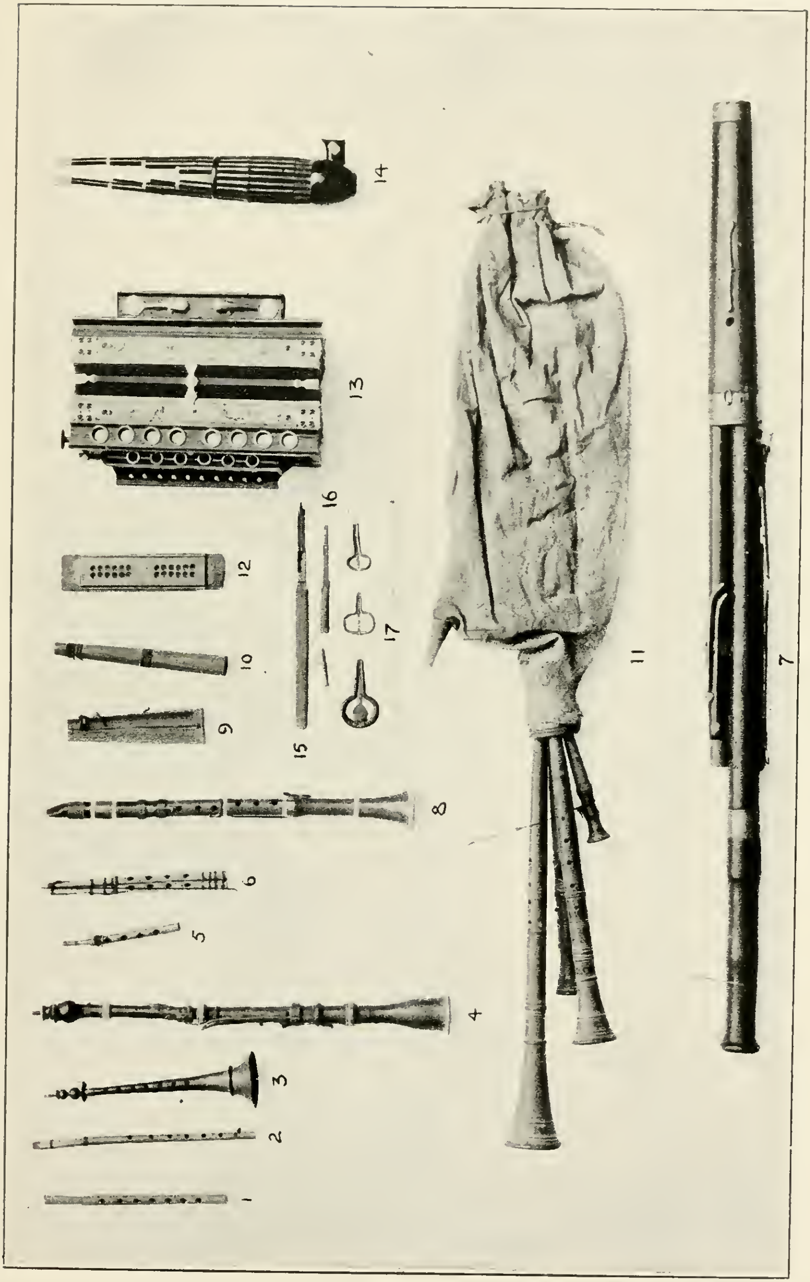
FOR EXPLANATION OF PLATE SEE PAGE 36

ANGOLA MUSICAL BOW.

FOR EXPLANATION OF PLATE SEE PAGE 37

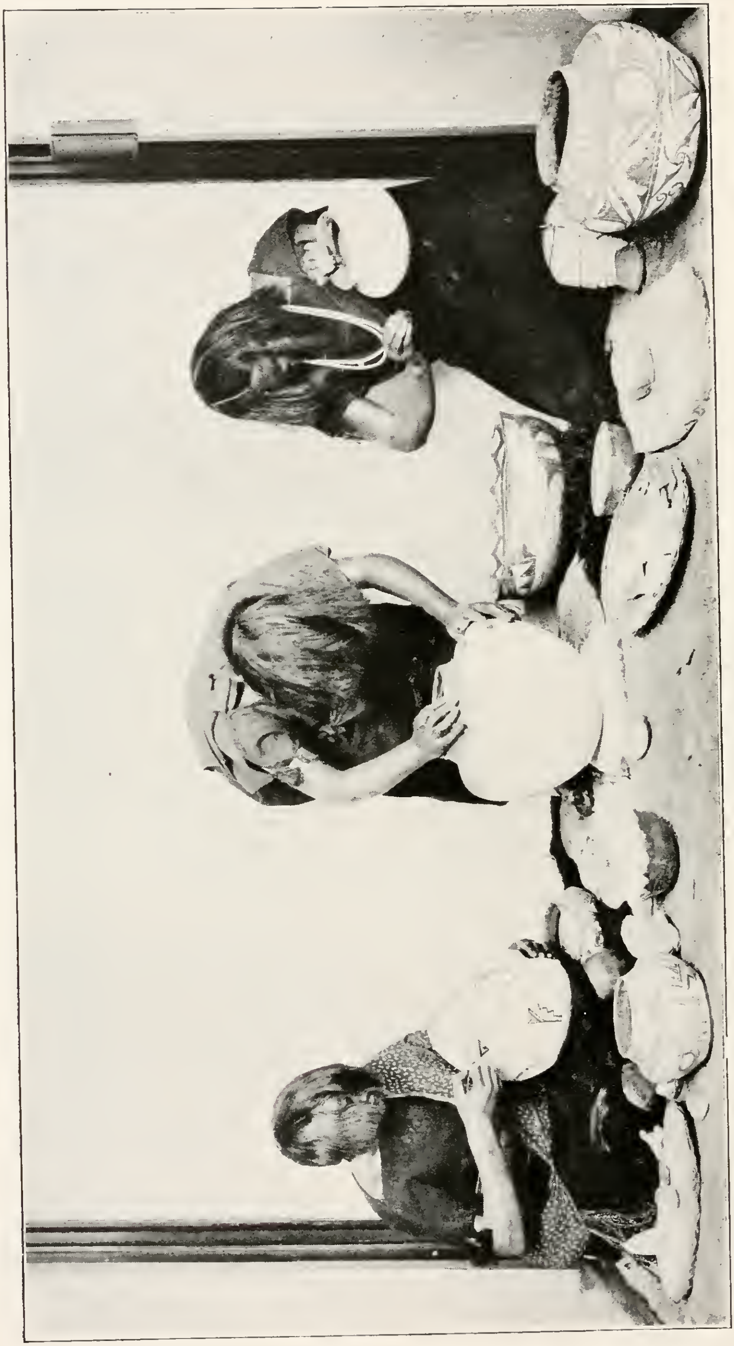
HISTORY OF WIND MUSICAL INSTRUMENTS.

FOR EXPLANATION OF PLATE SEE PAGE 37.



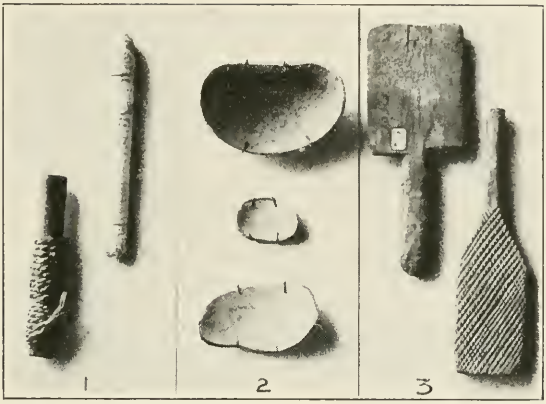
HISTORY OF REED MUSICAL INSTRUMENTS.

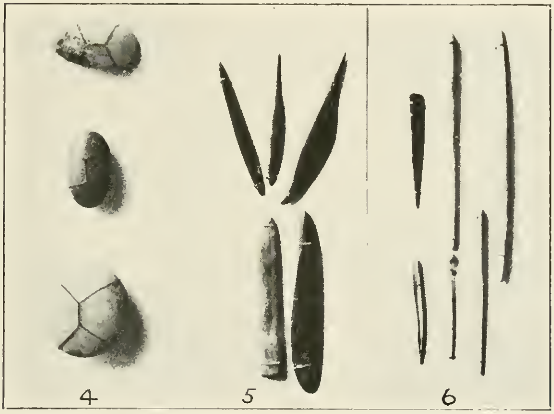
FOR EXPLANATION OF PLATE SEE PAGE 38

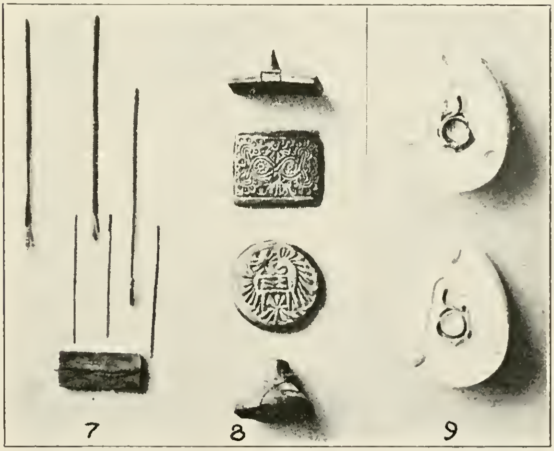


INDIAN WOMEN MAKING POTTERY.

FOR EXPLANATION OF PLATE SEE PAGE 40.

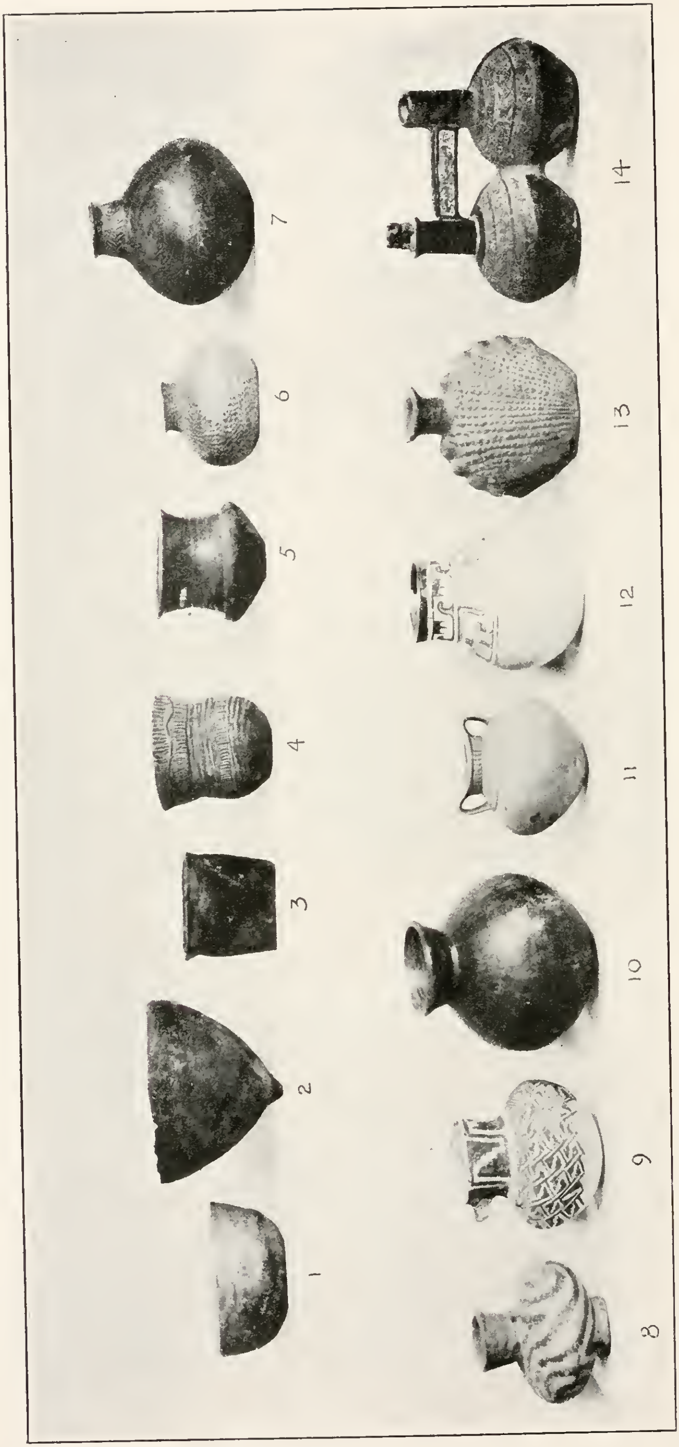






HISTORY OF TOOLS USED IN POTTERY MAKING.

FOR EXPLANATION OF PLATE SEE PAGE 41

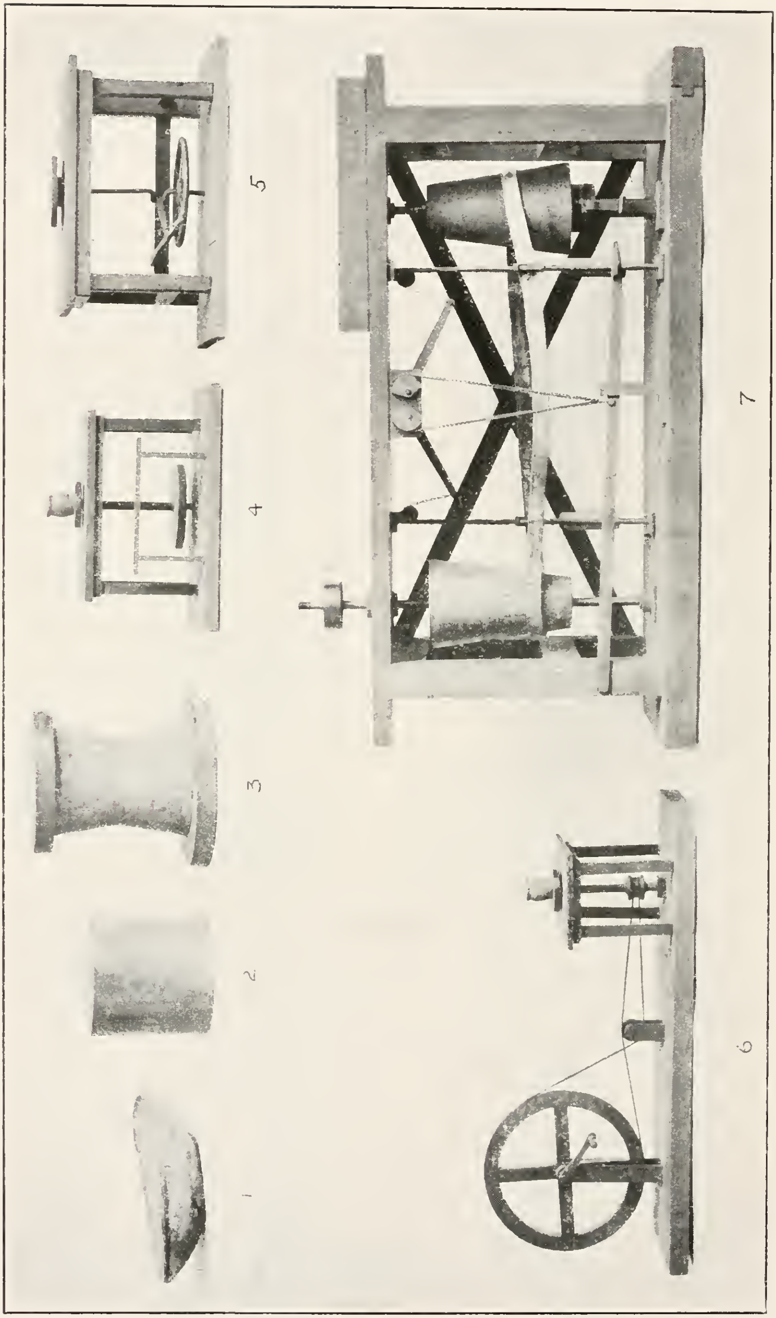


HISTORY OF VASE.

FOR EXPLANATION OF PLATE SEE PAGE 41.

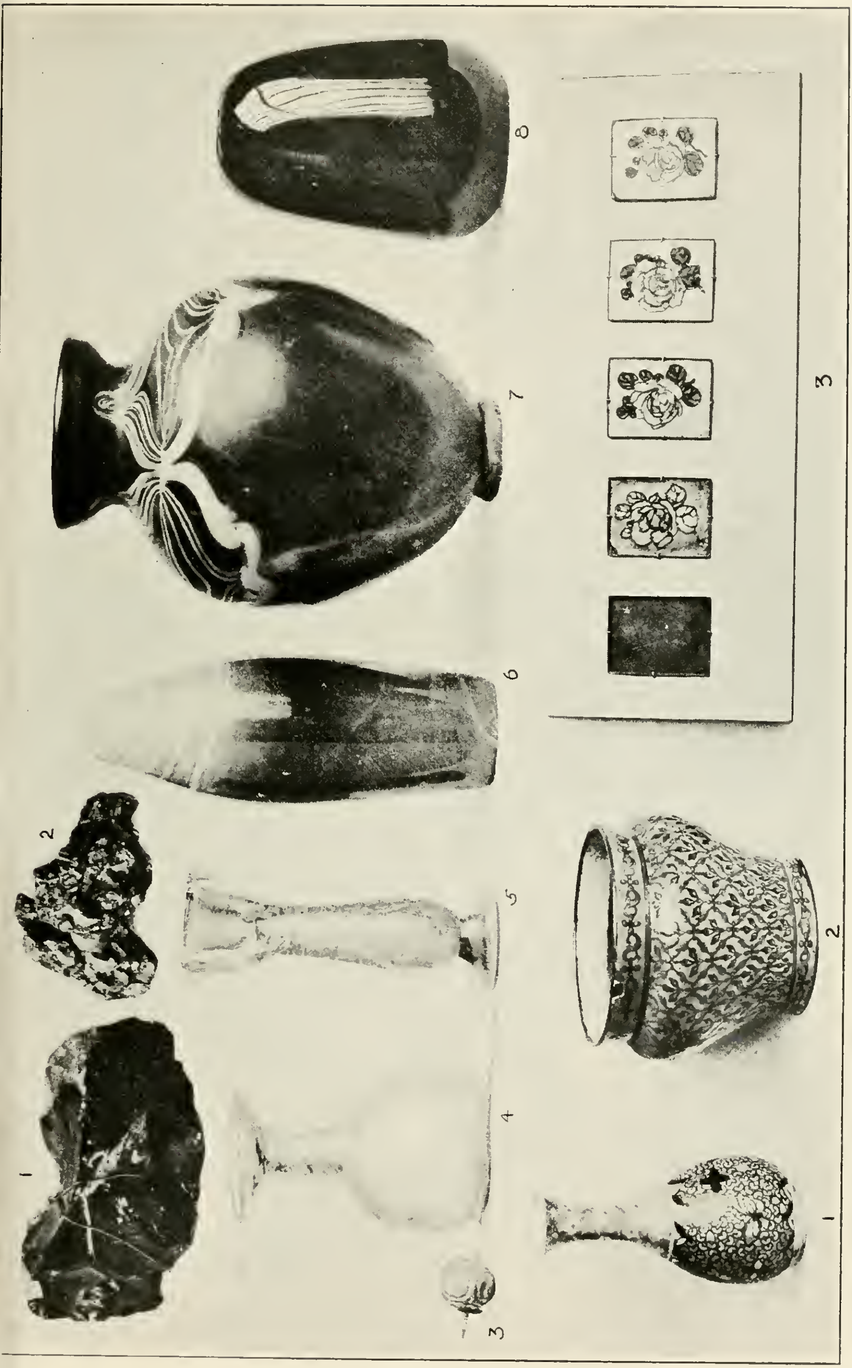
HISTORY OF VASE—CONTINUED.

FOR EXPLANATION OF PLATE SEE PAGE 41.



HISTORY OF POTTER'S WHEEL.

FOR EXPLANATION OF PLATE SEE PAGE 43.

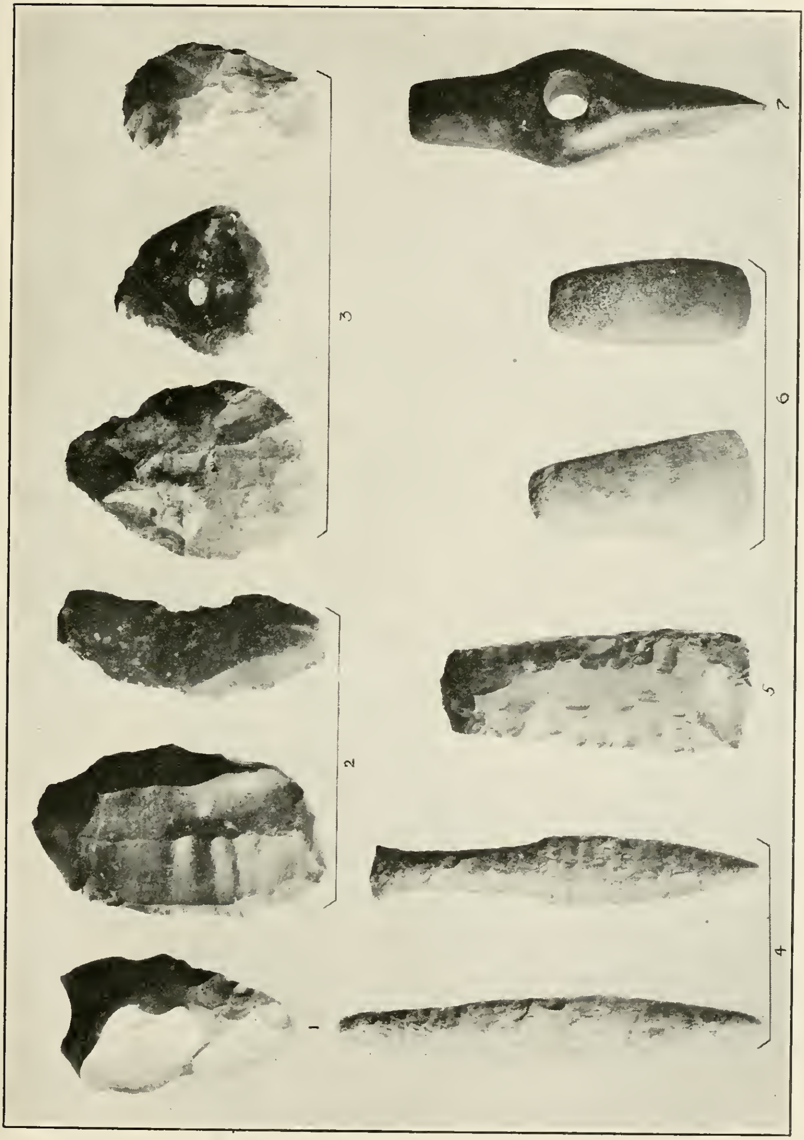


HISTORY OF GLASS AND ENAMEL.

FOR EXPLANATION OF PLATE SEE PAGES 43 AND 44

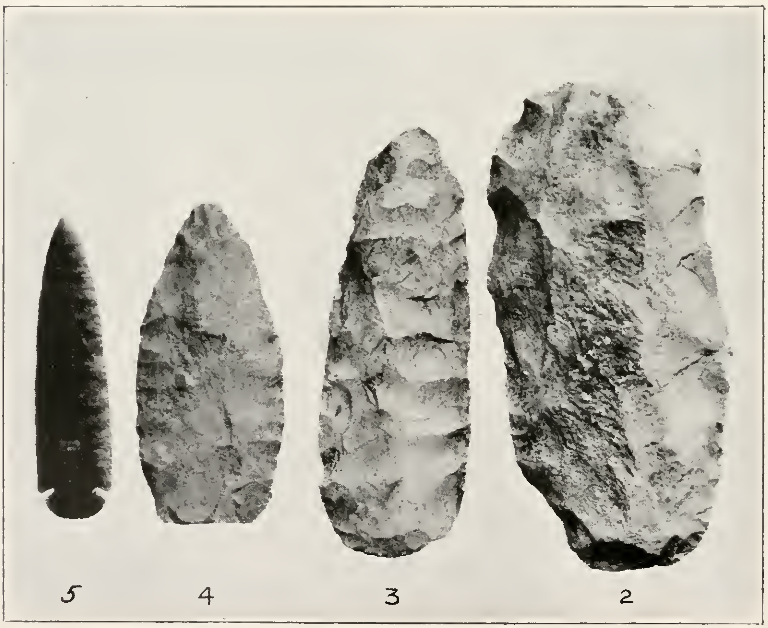
INDIAN FLINT BREAKERS.

FOR EXPLANATION OF PLATE SEE PAGE 45.



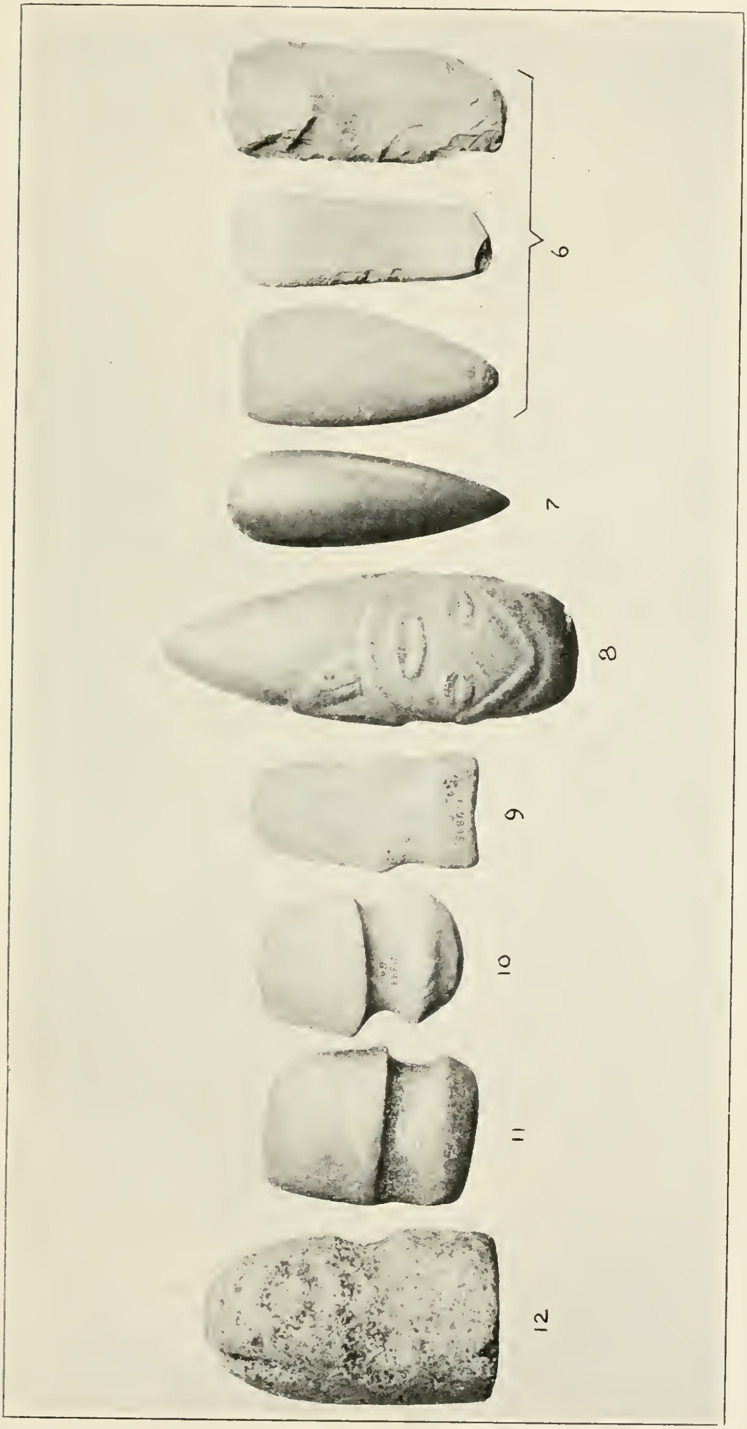
HISTORY OF EUROPEAN SCULPTURE.

FOR EXPLANATION OF PLATE SEE PAGE 45.



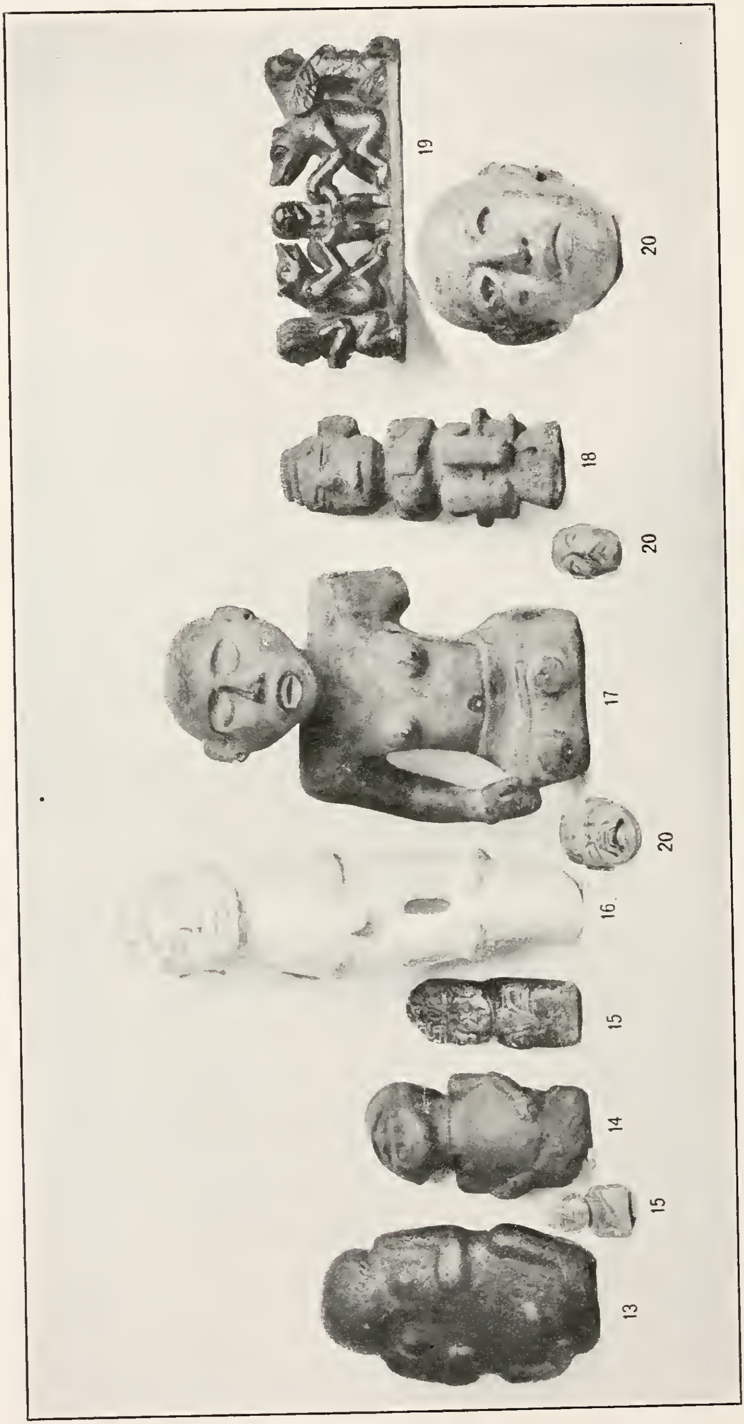
HISTORY OF ABORIGINAL AMERICAN SCULPTURE.

FOR EXPLANATION OF PLATE SEE PAGE 46.



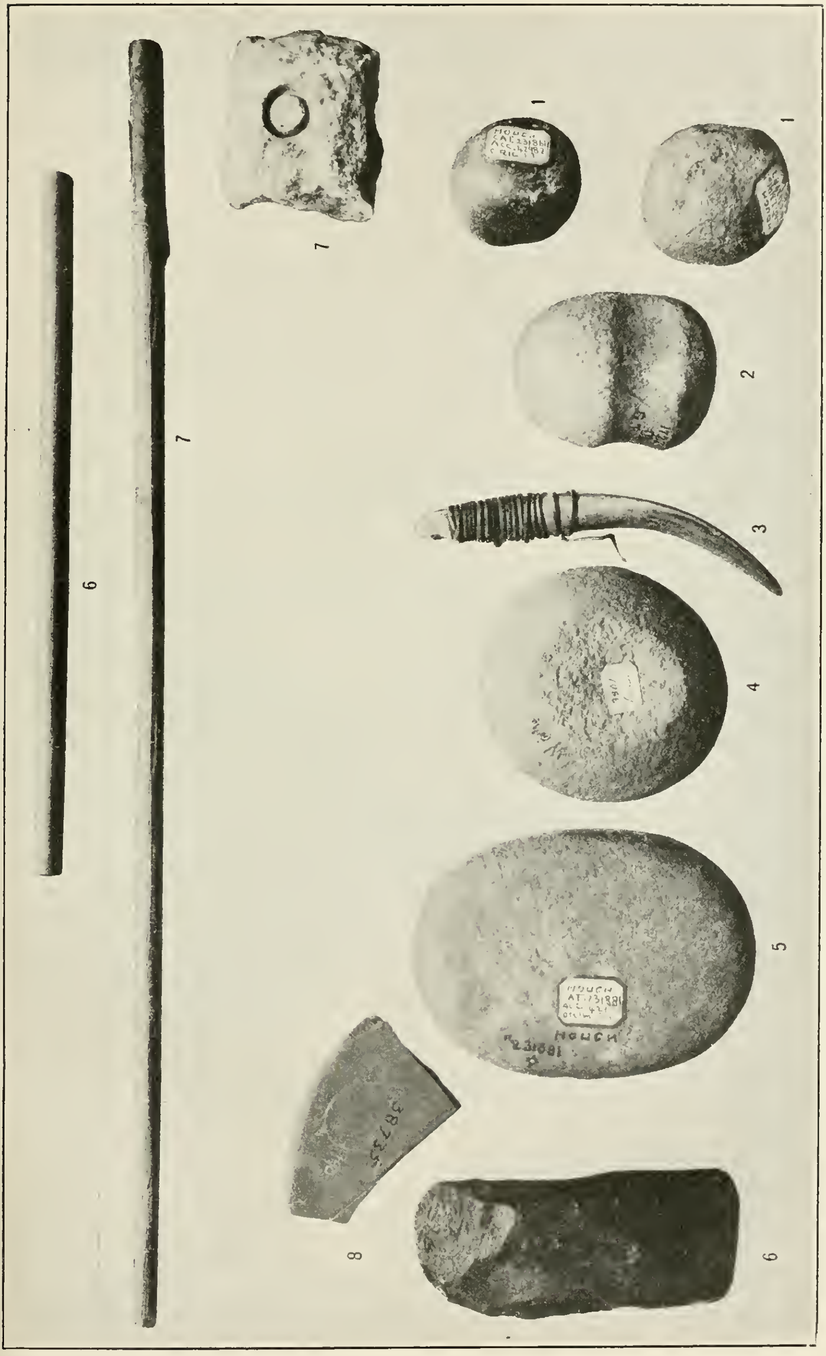
HISTORY OF ABORIGINAL AMERICAN SCULPTURE—CONTINUED.

FOR EXPLANATION OF PLATE SEE PAGE 46.



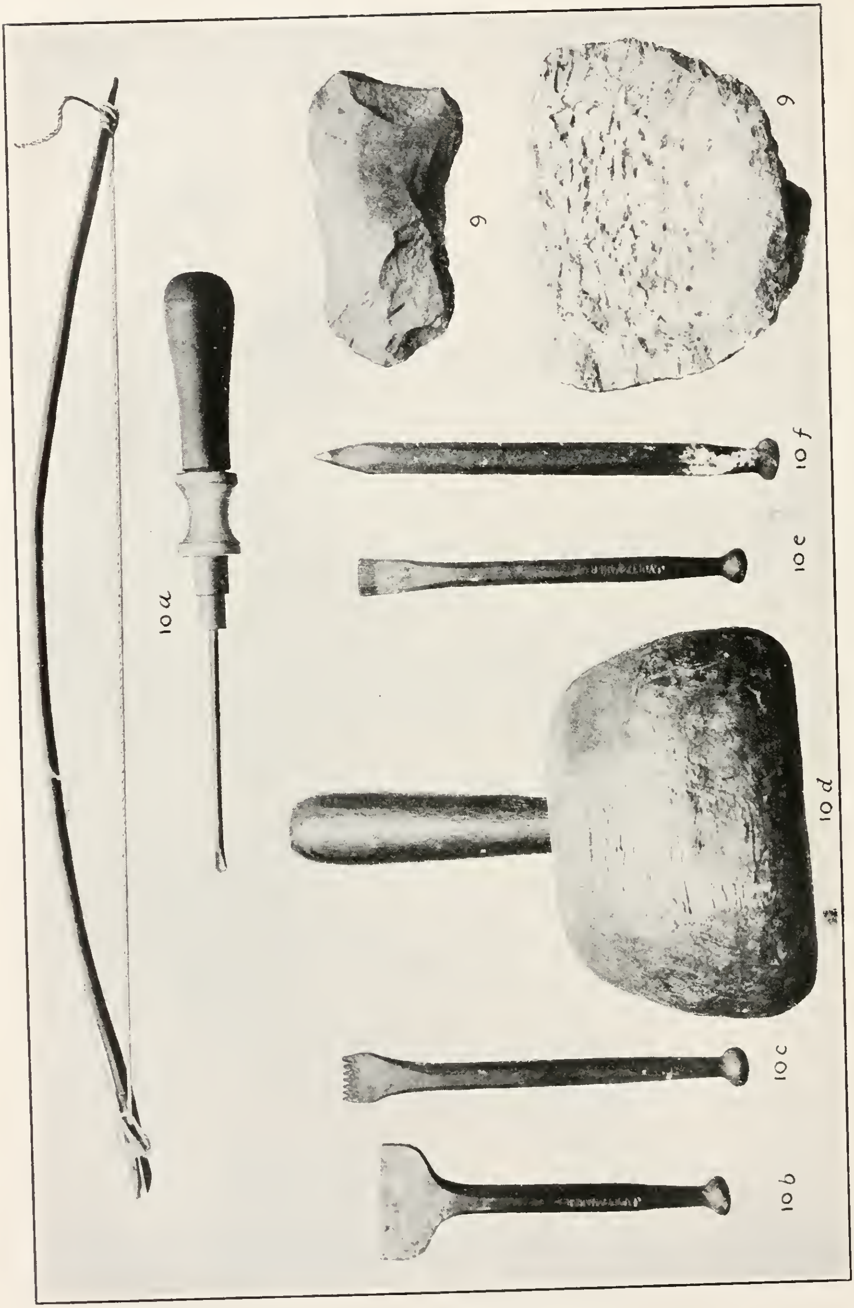
HISTORY OF ABORIGINAL AMERICAN SCULPTURE—CONTINUED.

FOR EXPLANATION OF PLATE SEE PAGE 46.



HISTORY OF TOOLS USED IN SHAPING STONE.

FOR EXPLANATION OF PLATE SEE PAGE 47.



HISTORY OF TOOLS USED IN SHAPING STONE—CONTINUED.

FOR EXPLANATION OF PLATE SEE PAGE 47.

AN ILLUSTRATED SYNOPSIS OF THE PUPARIA OF 100 MUSCOID FLIES (DIPTERA).

By Charles T. Greene,

Of the Bureau of Entomology, United States Department of Agriculture.

INTRODUCTION.

Those who have ever been engaged in the interesting pursuit of rearing parasitic insects doubtless have been impressed with the great desirability of having at hand some means of determining before the issuance of the adult insect the probable identity of the species under observation. This advance information often would not only render possible the collection of additional valuable material of the same kind but enable the observer in many cases to know months in advance of the issue of the adult parasite the species with which he was dealing. All students of the Muscoidean flies who have attempted to rear the larvae of this group, as well as other students of insect biology engaged in the study of the parasitology of any insect, have experienced the pangs of disappointment caused by the death of a unique specimen after pupation has occurred. In most such cases in the past this has resulted in the complete loss of the notes accumulated previous to the death of the parasite, but it is believed that by using the means proposed in this brief preliminary paper such losses may largely be overcome in the future, at least where the species treated in this paper are involved.

Several years ago, while engaged in studies of the Muscoidean flies in relation to their hosts, Mr. W. R. Walton became greatly impressed with the great variety and seeming constancy of the characters presented by the puparia of the members of this vast complex, which came under his notice. This suggested the possible construction of an illustrated synopsis, based on puparial characters, for the determination of some of the forms most commonly reared in the study of economic insects. With this in view he began to accumulate material and prepare drawings as opportunity offered. After 32 drawings had been made, in 1916, the assignment of administrative work compelled the abandonment of these plans, and all of the material, drawings, and notes were turned over to the present author, with the idea that he might proceed with them as he saw fit. The

preparation of the remainder of the plates, the drawing of descriptions, the construction of the synopsis, and arrangement of the illustrations, as well as the synonymy, are the work of the author, except as may be specifically indicated hereafter. Only those puparia from which the adult fly issued and was authoritatively determined have been used as a basis for this work, and such specimens have been preserved for future reference in the United States National Museum.

This paper is based on the puparia of one hundred species of Muscoidean flies, of which 99 have been figured, two species being so closely similar as not to be separable by this means. The puparia of a considerably greater number were examined in order to test the characters upon which the present work is based, and, with a single exception, the determination of the species of the puparium in hand was easily accomplished by means of the following synopsis. The exception referred to is that of *Frontina aletiae*, which it has been found impossible to separate from that of *Frontina archippivora*. Apparently these species are very closely allied.

The principal characters used are as follows:

Stigmal plate. (Pl. 1, fig. 1.)—The posterior stigmata are heavily chitinized and divided into two distinct areas, each area being called a *stigmal plate.* Each plate has two or more openings for respiration, and these openings are called *slits*, which connect with the main tracheae.

Slits. (Pl. 1, fig. 3.)—Various terms are used herein to designate the different types or styles of slits, as follows:

Serpentine. (Pl. 4, figs. 15–17.)—This term means a long winding slit somewhat resembling a snake or serpent. It may have few or many curves.

Brain coral. (Pl. 3, fig. 12.)—This term means that the slits are so formed that the surface of the stigmal plate has a great resemblance to brain coral (*Meandrina*, various species).

Plain slits. (Pl. 1, fig. 1.)—These vary from straight to slightly curved or angulated.

Button. (Pl. 1, fig. 2.)—This character varies in shape from round to nearly square and may be slightly raised or depressed. Its position varies a little, but it is always to be found on the inner half of the stigmal plate, or that half nearest the vertical axis. The button, according to Dr. J. C. H. De Meijere,[1] is the vestigial remains or scar of the posterior stigmata of the first stage larva. The stigmal plate afterwards forms around this scar and becomes heavily chitinized in the last stage of the larva.

Ridges. (Pl. 1, fig. 3.)—Elevations on the dorsum of the stigmal plate and upon each ridge is located a slit. The ridge is always

[1] Tijdschr. v. Entom., vol. 38, 1894, pp. 65–100.

longer than broad and its general contour follows that of the slit. The ridges are heavily chitinized and are a part of the stigmal plate.

Leaf-shaped.—Plate shaped like digitate leaf (see fig. 31).

By the application of the characters given above, which are all of a structural nature, the forms under treatment separate naturally into five primary divisions or groups, some of which subsequently are subdivided. The puparium of a given species may vary greatly in size as well as in color. The size, of course, is variable in direct proportion to the variation in the food supply, as shown by W. R. Walton in a former paper.[2] But the shape of the puparium, regardless of its size, is quite constant, while the form of the stigmal plates is remarkably constant. The latter, of course, vary in size with the puparium, but their outline is practically invariable in form. The location of the stigmal plates and also of the anal opening in relation to the longitudinal axis of the puparium constitute a group of characters which are not only easy of application but whose constancy renders them exceedingly reliable for diagnostic purposes. The author has found the stigmal plates of the full-grown larvae in several species to be fully as reliable as in the puparia.

The author solicits puparia of the Tachinidae and Dexiidae new to the National Collection for study purposes, and will especially appreciate the receipt of such puparia as can not be determined by means of this synopsis. He will agree to determine such material so near as may be possible and return such duplicates as are not required for further study. It is his intention to publish additional synopses of similar character as material and opportunity offer.

EXPLANATION OF TERMS USED IN SYNOPSIS.

Hairy type. (Pl. 1, figs. 1–5.)—Surface of the puparium entirely covered with short, nearly erect hairs, sometimes very short.

Smooth type. (Pl. 2, figs. 6–10.)—Puparium is practically without hairs, excepting the usual abdominal fusiform areas. The surface may be dull or shining.

Pit or cavity. (Pl. 2, figs. 9–10.)—A depression on the posterior end of certain puparia, in which are located the stigmal plates. It may be very shallow or deep. In some cases its depth is about equal to the diameter or greatest width of its opening at the surface of puparium.

Protuberant. (Pl. 10, fig. 45.)—Rising above the general surface of the puparium. Viewed from the side it may be either obtusely curved, conical, or truncate in form.

Tuberculate.—A cylindrical projection, of varying length, above the surface (see fig. 32).

[2] Proc. Ent. Soc. Wash., vol. 15, 1913, pp. 21–28.

Longitudinal axis.—A line drawn through the center of the greatest diameter of the puparium and emerging at the pole or center of the anal end thereof (see drawing fig. 1, pl. 1).

In view of the purely preliminary character of this paper and the fact that the arrangement of the synopsis is highly artificial, it has been deemed advisable to make use of the nomenclature most familiar to the greater number of workers. The author has reason to believe that the names found in Mr. D. W. Coquillett's "Revision of the Tachinidae" fulfill this requirement, and for this reason they have been adopted; but for the benefit of those who prefer the Townsendian names, and also for the information of those students who may be unacquainted with the synonymy of the two systems, the names used by Dr. C. H. T. Townsend are given in parentheses immediately following the preferred name.

The obligation of the author to Dr. J. M. Aldrich for his kind assistance in the determination of specimens, as well as for many useful suggestions, is most willingly acknowledged. Doctor Aldrich has also donated valuable material from his private collection of the Muscoidean flies. Mr. Harrison E. Smith has been most generous in donations of material, the remainder of which came from the several branches of Cereal and Forage Insect, Deciduous Fruit Insect, and Forest Insect Investigations of the Federal Bureau of Entomology, with the inclusion of some material from the private collection of Mr. W. R. Walton, which has now been presented to the United States National Museum, and where all the material used in the preparation of this paper has been deposited. I am also indebted to Mr. Walton for his many suggestions and his friendly criticism.

SYNOPSIS OF PUPAL CHARACTERS.

KEY TO THE GROUPS.

1. Puparium bearing spine-like hairs ---------- Group A
   Puparium without spines ---------- 2
2. Spiracles below the surface of the puparium, in a pit or cavity ---------- Group B
   Spiracles above the surface of the puparium, not in a pit or cavity ---------- 3
3. Spiracular slits resembling brain coral ---------- Group C
   Spiracular slits plain or serpentine ---------- 4
4. Spiracular slits serpentine ---------- Group D
   Spiracular slits plain (straight or only slightly curved) ---------- Group E

GROUP A.

Puparium distinctly hairy; bearing spine-like hairs.

KEY TO THE SPECIES.

1. Puparium truncate posteriorly ---------- **(No. 1) Sturmia sociabilis Greene.**
   Puparium not truncate posteriorly ---------- 2
2. Oblique posteriorly, in profile ---------- 3
   Not oblique posteriorly ---------- 4

3. Posterior spiracles far above the longitudinal axis line, located in a trilobed area______________________________(No. 2) **Sturmia distincta** Wiedemann.
   Posterior spiracles touching the longitudinal axis line; not in a trilobed area______________________________(No. 3) **Phorocera meracanthae** Greene.
4. Posterior spiracles in a smooth, bare, octagonal area.
   (No. 4) **Sturmia inquinata** Van der Wulp
   Posterior spiracles in a round, hairy area.
   (No. 5) **Celatoria diabrotica** Shimer.

GROUP B.

Spiracles in a pit or cavity; spiracles below the surface of the puparium, without spine-like hairs.

KEY TO THE SPECIES.

1. Bottom of pit entirely chitinous and very rugose.
   (No. 6) **Ptilodexia tibialis** Desvoidy.
   Bottom of pit not chitinous____ 2
2. Puparium small; spiracles with three very small, parallel slits.
   (No. 7) **Hilarella siphonina** Zetterstedt.
   Puparium small; stigmal plates pointed towards the base; slits long, parallel.
   (No. 8) **Pachyophthalmus floridensis** Townsend.
   Puparium large; spiracles rather large________________________________ 3
3. Puparium with a deep pit; a wide angular, transverse depression below the pit_____________________________________(No. 9) **Megaparia opaca** Coquillett.
   Pit very shallow; no depression beneath the pit.
   (No. 10) **Zelia vertebrata** Say.

GROUP C.

Spiracular slits resembling brain coral.

KEY TO THE SPECIES.

1. Puparium elongated, conical; stigmal plate with three lobes; each lobe with numerous small slits___________________(No. 11) **Beskia aelops** Walker.
   Puparium not elongated and conical____________________________________ 2
2. Spiracular protuberances well separated at the base; stigmal plate broadly elliptical; slits wide; button large, round, in the center of the plate.
   (No. 12) **Oestrophasia ochracea** Bigot.
   Spiracular protuberances touching at the base__________________________ 3
3. Spiracular plate elongate triangular; slits broad.
   (No. 13) **Phasmophaga antennalis** Townsend.
   Spiracular plate not triangular; slits linear and angular.
   (No. 14) **Coquillettina plankii** Walton.

GROUP D.

Spiracles with serpentine slits, resembling a snake or serpent.

KEY TO THE SPECIES.

1. Posterior spiracles on the dorsum of the puparium; segmental lines distinct dorsally; large puparium__________(No. 15) **Belvosia bifasciata** Fabricius.
   Posterior spiracles not on the dorsum of the puparium________________ 2
2. Posterior spiracles distinctly protuberant ____________________________ 3
   Posterior spiracles not protuberant _________________________________ 7

3. Posterior spiracles with two slits; protuberance roughly granular.
(No. 16) (Leucostoma) **Dionea atra Townsend.**

Posterior spiracles with three slits ---- 4

4. Spiracles almost on the dorsum; the puparium large.
(No. 17) **Microphthalma disjuncta Wiedemann.**

Spiracles on the longitudinal axis line ---- 5

5. Spiracles somewhat cylindrical; widely divergent; segmental lines distinct.
(No. 18) **Exorista lobeliae Coquillett.**

Spiracular protuberances close together ---- 6

6. Puparium enlarged on caudal half; spiracles contiguous at the base.
(No. 19) **Gymnosoma fuliginosa Desvoidy.**

Puparium slightly pointed on caudal end; spiracles touch at the base; from above, they are separated by a V-shaped space.
(No. 20) **Ocyptera carolinae Desvoidy.**

7. Segmentation very distinct; a prominent elevation between the spiracles.
(No. 21) **Exorista confinis Fallén.**

Segmentation not distinct ---- 8

8. Spiracles distinctly raised above the surface ---- 9

Spiracles very slightly raised above the surface ---- 10

9. Spiracles located at the apex of the puparium; slits not located on definite ridges ---- (No. 22) **Trichopoda pennipes Fabricius.**

Spiracles located below the apex; slits located on a definite narrow ridge.
(No. 23) **Trichopoda lanipes Fabricius.**

10. With four slits ---- 11

With three slits ---- 13

11. Spiracular plates very small, on the longitudinal axis line.
(No. 24) **Phorocera saundersii Williston.**

Spiracular plates larger, not on the longitudinal axis ---- 12

12. Spiracular plates quite close together; second slit from the bottom rather long ---- (No. 25) **Exorista boarmiae Coquillett.**

Spiracular plates quite small and widely separated; second slit from the bottom is S-shaped ---- (No. 26) **Hyphantrophaga hyphantriae Townsend.**

13. Spiracles widely separated; a high elevation between the spiracles; elevation much wider at the bottom and pointed on both sides.
(No. 27) **Exorista eudryadae Townsend.**

Spiracles widely separated; a large elevation between and below the plates; the elevation notched above on each side.
(No. 28) **Frontina frenchii Williston.**

Not as above ---- 14

14. Spiracles close together on the longitudinal axis line; a transverse, elliptical elevation with pointed ends at the base of the spiracles.
(No. 29) **Linnaemyia fulvicauda Walton**

Spiracles well separated; three distinct lobes; only a slight elevation below spiracles.
(No. 30) **Frontina aletiae Riley; Frontina archippivora Williston.**

GROUP E.

KEY TO THE SECTIONS.

End of puparium with a large rounded tubercle ---- **Section 1**

End of puparium without a large rounded tubercle ---- **Section 2**

SECTION 1.

End of puparium with a large rounded tubercle.

KEY TO THE SPECIES.

1. Spiracular plates each have five slits-------------------------------- 2
   Spiracular plates each have three slits------------------------------- 3
2. Stigmal plate located on a large tubercle, which is below the longitudinal axis line--------------------------(No. 31) **Clausicella tarsalis Coquillett.**
   Stigmal plates with short slits, each plate on top of a tube-like projection located on a rounded tubercle far above the longitudinal axis.
   (No. 32) **Tachinophyto tortricis Coquillett.**
3. Tubercle very large; diameter nearly equal to the end of the puparium- 4
   Tubercle much smaller--- 5
4. Stigmal plates reddish in the center; located below the longitudinal axis
   (No. 33) **Sturmia pilatei Coquillett.**
   Stigmal plates nearly round, black; located above the longitudinal axis.
   (No. 34) **Exorista pyste Walker.**
5. Tubercle near bottom surface of the puparium-------------------------- 6
   Tubercle much higher up--- 7
6. Tubercle very large; longitudinal axis line near upper edge.
   (No. 35) **Tachinophyto variabilis Coquillett.**
   Tubercle small; bottom surface of puparium nearly straight.
   (No. 36) **Tachinophyto floridensis Townsend**
7. Tubercle directed obliquely upward.
   (No. 37) **Phorichaeta cinerosa Coquillett.**
   Tubercle small, very prominent; puparium quite small.
   (No. 38) **Actia pilipennis Fallén**
   Tubercle not so prominent--- 8
8. Puparium very small; tubercle divided vertically on the apex; each plate has three small slits-----------------(No. 39) **Siphona geniculata de Geer.**
   Puparium slightly larger; stigmal plates nearly rectangular; slits very narrow--------------------------------(No. 40) **Siphona plusiae Coquillett.**
   Puparium not as above--- 9
9. Posterior end of the puparium tapering into the tubercle--------------- 10
   Posterior end rounded; tubercle distinct but not tapered-------------- 11
10. Puparium rather slender; ventral surface slightly concave.
    (No. 41) **Panzeria penitalis Coquillett.**
    Puparlum more robust; apex bifid; button very large, size nearly equal to ridges containing the slits------(No. 42) **Leskiomima tenera Wiedemann.**
11. Posterior end of puparium with a round tubercle above the center of the apex; slits parallel-----------------(No. 43) **Paraplagia spinulosa Bigot.**
    Posterior end flat; spiracles slightly raised; three curved slits, not parallel.
    (No. 44) **Metachaeta helymus Walker.**

SECTION 2.

End of puparium without a large rounded tubercle; spiracles distinctly protuberant or slightly or distinctly raised above the surface.

KEY TO THE SPECIES.

1. Spiracles distinctly protuberant ------------------------------------- 2
   Spiracles slightly or distinctly raised above the surface of the puparium- 7

2. Puparium very small; spiracular protuberance entirely smooth and shining ---------- 3
   Puparium of medium size or larger; protuberance only partly smooth---- 4
3. Posterior spiracular protuberance cone-shaped, with a groove between the stigmal plates----------(No. 45) **Alophora pulverea** Coquillett.
   Posterior spiracular protuberance deeply bifid on apical half and pointing obliquely downward----------(No. 46) **Phorantha occidentis** Walker.
4. Protuberance granular at base only---------- 5
   Protuberance entirely granular or spiny---------- 6
5. Spiracles widely separated, granular on the basal half only.
   (No. 47) **Frontina ancilla** Walker.
   Spiracles solid and granular at the base, deeply bifid on apical half.
   (No. 48) **Clytiomyia flava** Townsend
6. Spiracles quite spiny on the sides, subdorsal; anterior spiracles prominent.
   (No. 49) **Plagia americana** Van der Wulp.
   Spiracles very rugose on the sides; slits with short branches; spiracles at the apex----------(No. 50) **Acemyia dentata** Coquillett.
7. Spiracles subdorsal; three lobes somewhat claw-shaped.
   (No. 51) **Eutrixa exile** Coquillett.
   Spiracles near the apex of puparium---------- 8
8. With four slits; stigmal plates very small.
   (No. 52) **Phorocera erecta** Coquillett.
   With three or six slits in each plate---------- 9
9. With six slits in each plate ---------- 10
   With three slits in each plate ---------- 12
10. Puparium cylindrical, slightly concave on the dorsum; slits nearly straight.
    (No. 53) **Cryptomeigenia theutis** Walker.
    Puparium greatly enlarged on the posterior end---------- 11
11. Stigmal plates contiguous; slits angulated.
    (No. 54) **Biomyia lachnosternae** Townsend.
    Stigmal plates small, widely separated; slits simple, only faintly curved.
    (No. 55) **Cryptomeigenia aurifacies** Walton
12. Segmentation distinct on the dorsocaudal end, concave on dorsocephalic half; stigmal plate triangular, with three very small slits.
    (No. 56) **Hyalomyodes triangulifera** Loew.
    Segmentation indistinct---------- 13
13. Button on stigmal plate very large, protruding---------- 14
    Button on stigmal plate normal ---------- 16
14. Button quadrate----------(No. 57) **Admontia hylotomae** Coquillett.
    Button rounded ---------- 15
15. Two upper slits nearly parallel; posterior end of puparium tapering.
    (No. 58) **Masicera, species (near exilis.)**
    Two upper slits divergent; posterior end not tapering.
    (No. 59) **Frontina armigera** Coquillett.
16. Posterior end of puparium very rugose; slits wide, nearly parallel.
    (No. 60) **Amobia confundens** Townsend.
    Posterior end not rugose---------- 17
17. Stigmal plates flush with surface; located in a triangular area.
    (No. 61) **Exorista amplexa** Coquillett.
    Stigmal plates above the surface of the puparium; puparium large------ 18
18. Puparium with a constriction near the posterior end forming a segment-- 19
    Puparium without a constriction ---------- 20

19. Apical segment narrow, of equal width.
(No. 62) **Chaetogaedia analis** Van der Wulp.
Apical segment hemispherical__________(No. 63) **Archytas analis** Fabricius.
Apical segment much wider below______(No. 64) **Archytas hystrix** Fabricius.
20. Puparium obliquely flat on posterior end; stigmal plate with three long slits.
(No. 65) **Archytas lateralis** Macquart.
Puparium not as above ____ 21
21. Bottom slit about horizontal ____ 22
Bottom slit not horizontal____ 23
22. The three slits of equal length____________(No. 66) **Gonia capitata** de Geer.
The upper slit much longer than either of the other two.
(No. 67) **Gonia exul** Williston.
23. Stigmal plates round; a large, prominent, transverse elevation below the stigmal plates________________________(No. 68) **Blepharipeza adusta** Loew.
Stigmal plates not round____ 24
24. Stigmal plate elliptical or oval; slits narrow.
(No. 69) **Masicera eufitchiae** Townsend.
Stigmal plate not as above____ 25
25. Stigmal plates small, subdorsal; two short ridges, with a groove between them vertically between the plates.
(No. 70) **Linnaemyia comta** Fallén.
Stigmal plates larger, not subdorsal____ 26
26. Upper slit horizontal, other two slits pointing obliquely downward; button near upper edge of plate__________(No. 71) **Peleteria robusta** Wiedemann.
Not as above____ 27
27. Puparium with a prominent elevation at base of stigmal plates________ 28
Puparium without such elevation____ 29
28. A large transverse elevation below the stigmal plates, extending up narrowly between them_________________________(No. 72) **Tachina mella** Walker.
Elevation rounded, depressed in center; at base of plates only.
(No. 73) **Euphorocera claripennis** Macquart.
29. Puparium quite small____ 30
Puparium medium to large size____ 32
30. Stigmal plates elliptical; slits small and the ridges narrow.
(No. 74) **Hypochaeta longicornis** Schiner.
Stigmal plates not elliptical; slits and ridges large____ 31
31. Stigmal plates widely separated; an elevation below and between plates; anal opening remote from stigmal plates.
(No. 75) **Phorocera tortricis** Coquillett.
Stigmal plates contiguous; no elevation below plates; anal opening much nearer stigmal plates______________(No. 76) **Phorichaeta sequax** Williston.
32. Stigmal plates somewhat flattened; slits and ridges very small. on the outer edge; button large, round____(No. 77) **Dichaetoneura leucoptera** Johnson.
Stigmal plate not as above____ 33
33. Inner slits and ridges noticeably larger than the others____ 34
Slits nearly equal in size____ 35
34. Two lower slits nearly parallel___________(No. 78) **Tachina rustica** Meigen.
Two lower slits not parallel__________(No. 79) **Tachina robusta** Townsend.
35. Slits faintly elevated; ridges indistinct____ 36
Slits located on ridges____ 42
36. Slits small, close together____ 37
Slits larger, remote____ 38
37. Stigmal plate broader above; puparium not very long.
(No. 80) **Masicera myoidea** Desvoidy.

Stigmal plate not broader above; puparium elongated.
(No. 81) **Sturmia nigrita** Townsend.

38. Stigmal plates near apex of puparium; two upper slits nearly parallel__ 39
Stigmal plates remote from apex; two upper slits not parallel__________ 40

39. All three slits of equal length; button fairly distinct.
(No. 82) **Frontina tenthredinidarum** Townsend.
Two outer slits converge toward the button; inner slit slightly longer than either of the other two__________(No. 83) **Exorista nigripalpis** Townsend.

40. Stigmal plates round or oval; slits large______________________________ 41
Stigmal plates small____ 42

41. Two outer slits straight, slightly bent at the base.
(No. 84) **Exorista griseomicans** Van der Wulp.
Inner slit large, straight, nearly perpendicular, other slits small, close together_____________________(No. 85) **Phorocera flavicauda** Van der Wulp.

42. Stigmal plates very small; ridges low and weak.
(No. 86) **Panzeria radicum** Fabricius.
Stigmal plates large; ridges strong and prominent____________________ 43

43. Ridges of plate touching each other; middle slit horizontal.
(No. 87) **Zelia**, species.
Ridges of plate not touching_______________________________________ 44

44. Puparium with a depression dorsally________________________________ 45
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46. Lower slit in stigmal plate horizontal_______________________________ 47
Lower slit in stigmal plate not horizontal____________________________ 52

47. Button on inner edge of plate_____________________________________ 48
Button not on inner edge of plate __________________________________ 49

48. Puparium slightly depressed dorsally on the posterior end.
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49. Ridges taper to a narrow point at one end_____________________________ 50
Ridges do not taper to a point_______________________________________ 51

50. All the ridges taper to a point at one end.
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(No. 93) **Exorista futilis** Osten Sacken.

51. Ridges about equal in size; a round elevation centrally depressed below the plates________________________(No. 94) **Phorocera claripennis** Macquart.
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55. Puparium small; ridges large, well developed.
(No. 98) **Sturmia occidentalis** Coquillett.
Puparium larger; ridges narrow, not well defined.
(No. 99) **Sturmia albifrons** Walker.

DESCRIPTIONS OF SPECIES.

1. STURMIA SOCIABILIS Greene.

Small, dull reddish yellow; surface covered with short, erect hairs; posterior end bare and rather blunt; segmentation rather distinct. Spiracles distinctly raised above surface, widely separated, and shining black. Three slits located on the upper surface of well-defined ridges. Spiracles located on longitudinal axis. Button round, located near outer slit. Anal opening small, located just below spiracles.

Length, 5 mm.; diameter, 2 mm.

2. STURMIA DISTINCTA Wiedemann (Zygosturmia distincta Wiedemann).

Medium sized; dull, dark red. Surface covered with short hairs; stigmal area bare, somewhat tuberculate at lower end. Spiracles subshining, black, slightly raised above surface of puparium; three yellowish slits, each located on top of a well-defined ridge. Button large, round, well-defined, and located near center. Spiracles located well above; anal opening located on longitudinal axis.

Length, 7 mm.; diameter, 3 mm.

3. PHOROCERA MERACANTHAE Greene.

Medium sized; dull, dark reddish brown; surface, except the stigmal area, covered with very minute spine like hairs. Spiracles shining black, smooth above, granular around the base; widely separated and distinctly raised above the surface. Three slits, each located on very prominent ridges. Button small but distinct. Spiracles touching upper side of longitudinal axis. Anal opening very remote from spiracles.

Length, 9.5 mm.; diameter, 4 mm.

4. STURMIA INQUINATA Van der Wulp (Zygosturmia inqeinata Van der Wulp).

Medium sized; dull, dark red; segmentation distinct; surface covered with short hairs. Spiracles shining black, nearly circular, raised slightly above the surface, with three slits located on well-defined ridges. Button round, well defined. A small area around the spiracles faintly rugose and destitute of short hairs; a faint tubercle at the base of this area. Spiracles located on longitudinal axis. Anal opening remote, located on basal segmental line of penultimate segment.

Length, 8 mm.; diameter, 3.25 mm.

5. CELATORIA DIABROTICAE Shimer.

Small; dull, dark red; entire surface covered with spine like hairs. Some spines are in clusters, and these clusters are arranged in

transverse rows. Spiracles black, slightly raised above the surface and located on the longitudinal axis. Three slits, reddish yellow, located on well-defined ridges. Button round and well formed. Anal opening very small, located far below the spiracles.

Length, 2.75 mm.; diameter, 1.25 mm.

6. PTILODEXIA TIBIALIS Desvoidy.

Very large; finely rugose, dull, dark red. Dorsum of puparium nearly straight, the bottom broadly curved. Spiracles shining black, with three slits, each slit located on top of a well-defined ridge. A well-defined button. Spiracles located in a pit which is quite rugose and chitinous. This pit is located in a protruded area which, from the side view, appears like two large folds. Edges of pit broadly rounded. Pit located entirely above the longitudinal axis. Near the cephalic end on each side of the puparium is a horn-like projection. Anal opening just below longitudinal axis.

Length, 13 mm.; diameter, 4.75 mm.

7. HILARELLA SIPHONINA Zetterstedt.

Small; smooth, dull, light red, with a depression on dorsum at about the apical fifth. Bottom edge nearly straight. Cephalic end of puparium slightly pointed and showing a trace of three segments. Spiracles are dark brown and located on the upper part of a deep pit. This pit is located mostly below the longitudinal axis, with but the upper edge of the pit touching the axis. The edge of this elliptical opening is black. Each spiracle has three slits nearly perpendicular and a definite button. Anal opening located on the lower or ventral edge of puparium.

Length, 5.25 mm.; diameter, 1.75 mm.

8. PACHYOPHTHALMUS FLORIDENSIS Townsend.

Small; elongate, dull, reddish yellow, tapering slightly towards the caudal end, which has a small, deep pit of a darker red color; black around the edge of this pit; the ventral surface slightly depressed. Spiracles located inside the pit, on the upper surface. The plates are separated by a space nearly equal to the width of one plate. Stigmal plates are black around the edge, with the central part deep reddish yellow. The plate is broad above, tapering down to a very broadly rounded point below. Each plate has three straight, parallel slits pointed at their lower end. Button large, round, and located at the lower end of the plate. Pit and spiracles are located on but entirely below the longitudinal axis. Anal opening large, located a short distance below the pit.

Length, 5 to 6.5 mm.; diameter, 1.5 to 2 mm.

9. MEGAPARIA OPACA Coquillett (Megapariopsis opaca Coquillett).

Large; elongated, very finely rugose, dark red. Upper surface faintly depressed. Spiracles shining black, located on the sides of a deep depression, which is coarsely rugose. The upper edge of this pit-like depression is rounded, lower part more flattened and projects off rather sharply, along the bottom, from the puparium. Below the edge of this depression is a prominent, rugose surface. Anal opening just below this prominence. Each spiracle has three slits, which are slightly yellowish; also a prominent button. On each side of the puparium, about the apical fourth, is a cylindrical, reddish yellow tubercle.

Length, 11 mm.; diameter, 3.5 mm.

10. ZELIA VERTEBRATA Say.

Very large, subshining, dark red. Upper surface in profile, nearly straight. The upper half of the posterior end flattened. Spiracles black, slightly raised above the surface and located in a shallow pit-like depression; the depression above the longitudinal axis. Each plate has three slits nearly parallel, each slit on top of a well-defined ridge. Button round. Anal opening very remote from spiracles, well below the longitudinal axis. On the side, near the apex, is a small, horn-like projection, the anterior spiracle.

Length, 13.75 mm.; diameter, 4 mm.

11. BESKIA AELOPS Walker.

Elongated; shining, yellowish red, tapering gradually, smaller toward the caudal end. Spiracles decidedly tuberculate, shining red, diverging, nearly touching at the base. The tubercles are roughly granular. The upper portion slightly larger, smooth, shining and divided into three sections or lobes. Each lobe has from about nine to eleven very small slits, each on a small elevation or ridge. Button very small, round. Spiracles located on the longitudinal axis, mostly below the line. Anal opening very small, on the under side of the puparium, the distance a little more than the length of one tubercle.

Length, 7 mm.; diameter, largest, 2 mm.; smallest, 1 mm.

12. OESTROPHASIA OCHRACEA Bigot (Ormia ochracea Bigot).

Large; dull-red puparium. Spiracles subshining, black, protuberant, well separated at the base, slightly larger at the base. Spiracles located on apex of tubercles. Each plate has three serpentine slits and a round button near the middle. Spiracles located just above longitudinal axis. Anal opening small, located quite remote from the spiracles.

Length, 7 mm.; diameter, 3.75 mm.

13. PHASMOPHAGA ANTENNALIS Townsend.

Medium-sized; dull, black puparium. Some specimens have a faint reddish tinge. Spiracles somewhat triangular in form, located on very prominent protuberances, which touch at the base and are separated by nearly their own width at the apex. Each spiracular plate has three lobes, and each lobe has very irregular, dark-yellow slits located on a shiny, black surface. Button well defined, located centrally on longitudinal axis. Anal opening small, located some distance below the spiracles.

Length, 7.5 mm.; diameter, 3 mm.

14. COQUILLETTINA PLANKII Walton (Hemithrixion plankii Walton).

Medium-sized; dull, blackish-red puparium. Spiracles shining black, located on well-defined protuberances, which touch at base and are separated at apex by nearly their own width. Slits are angular and located on top of well-defined ridges. Button well marked. Protuberances located above but touching longitudinal axis. Anal opening very small, located near middle of lower half of end view.

Length, 6.5 mm.; diameter, 2.75 mm.

15. BELVOSIA BIFASCIATA Fabricius (Latreillemyia bifasciata Fabricius).

Very large; dull black puparium. Caudal end larger than anterior end. Spiracles located on the dorsum from one-quarter to one-third the distance from the caudal end; slightly raised above the surface of the puparium, with three very long serpentine slits, which are slightly yellowish. Button round, distinct. Segmental lines plainly seen on the dorsum. Anal opening small, indistinct, crescent-shaped, located just above longitudinal axis.

Length, 14 mm.; diameter, 6.5 mm.

16. LEUCOSTOMA ATRA Townsend (Dionea atra Townsend).

Small; smooth, elliptical, dull yellowish red. Spiracles protuberant, black, shining at apex, dull and finely granular at base, located on longitudinal axis, mostly below the line, each with two serpentine slits situated on top of a prominent protuberance, these protuberances narrowly separated at base; inside flat surfaces nearly parallel. Anal opening less than width of the protuberance from same.

Length, 4 mm.; diameter, 1.5 mm.

17. MICROPHTHALMA DISJUNCTA Wiedemann.

Very large; dull, dark red, with a slight depression on the dorsum. Spiracles protuberant, located high up, subdorsally. They are shining black; three serpentine slits and a well-defined button to each;

separated by a space equal to the length of one spiracle. Anal opening large, located far below the spiracles.

Length, 12.5 mm.; diameter, 5 mm.

18. EXORISTA LOBELIAE Coquillett.

Large; subshining, dark red or reddish black; segmentation fairly well marked with small punctures. Spiracles tuberculate. Stigmal plates blackish, located on distinct tubercles. These tubercles are separated at their base by a distance equal to one and one-half times the length of one plate. Each plate has three serpentine slits, one above and two below. Button distinct, round, located near center of plate. Immediately below the spiracles is a well-defined, rounded, deep reddish-yellow tubercle, with an indentation on the apex. Spiracles located on longitudinal axis. Anal opening small, very remote from spiracles.

Length, 6.75 mm.; diameter, 3 mm.

19. GYMNOSOMA FULIGINOSA Desvoidy.

Medium size; dull, dark red to a very dark reddish brown. Some specimens vary slightly by having the caudal end somewhat enlarged. In other specimens, the general outline is more elliptical. Spiracles are shining black, protuberant, touching at the base, separated by a V-shaped space. Each spiracle has three serpentine slits. Button large, round, not very well defined. Anal opening small, just beneath the spiracles. Spiracles located on the longitudinal axis.

Length, 6.5 mm.; diameter, 3 mm.

20. OCYPTERA CAROLINAE Desvoidy.

Medium size; elongated, dull, dark red; caudal end slightly pointed; surface microscopically rugose. Spiracles protuberant, shining black, with a granular, narrow area at the base. Spiracles are connected at the base and the plates are separted by a V-shaped space. Each plate is divided into three lobes. Each lobe has a reddish-yellow, serpentine slit. Button large, round. Anal opening small, located just below the spiracles. Spiracles located on the longitudinal axis.

Length, 7 mm.; diameter, 2.4 mm.

21. EXORISTA CONFINIS Fallén (Aplomyia confinis Fallén).

Large; shining, dark red, with the segments well marked with puncture-like marks. Largest diameter about the posterior third; posterior end somewhat pointed. Stigmal plates blackish, located about the length of one plate below the longitudinal axis; plates slightly raised above surface and separated by a space about half

the width of one plate. Each plate has three yellowish, serpentine slits, one above and two, S-shaped, below. Button round, well defined. Area between the plates with a slight ridge broadening below, becoming somewhat tubercular, with an uneven depression in the center.

Length, 7 mm.; diameter, 3.25 mm.

22. TRICHOPODA PENNIPES Fabricius (Trichopodopsis pennipes Fabricius).

Large; dull, dark red. Spiracles raised well above the surface of puparium, shining black, each with three serpentine slits and a well-defined button; located on longitudinal axis narrowly separated at the base and more widely separated at the apex. Anal opening quite close to spiracles.

Length, 8 mm.; diameter, 3.75 mm.

23. TRICHOPODA LANIPES Fabricius (Galactomyia lanipes Fabricius).

Quite large; dull, dark reddish. Upper surface very faintly depressed. Spiracles shining black, slightly raised above surface, with three serpentine, well-defined slits. Button not very clearly defined. Spiracles located nearly the length of one plate below the longitudinal axis. Inner edges of the spiracular plates parallel and separated by a very narrow space. Anal opening small, close to spiracles; anal plate transversely elliptical.

Length, 10 mm.; diameter, 5 mm.

24. PHOROCERA SAUNDERSII Williston (Madremyia saundersii Williston).

Medium size; dull, dark red. Spiracles shining black, slightly raised above the surface; plates separated by a space equal to one half the width of one plate. Between the plates are two well-marked grooves the same length as the plates. Each plate has four very small, serpentine, yellow slits. Button large, round, well defined. Spiracles located on the upper side of the horizontal axis. Below them is a prominent, transverse elevation slightly blackened. Anal opening small, far below the spiracles.

Length, 7 mm.; diameter, 3 mm.

25. EXORISTA BOARMIAE Coquillett (Eusisyropa boarmiae Coquillett).

Medium size; subshining, yellowish red. Spiracles shining black, deep reddish in center, slightly raised above the surface, widely separated, space equal to one-half the width of one plate. Each plate has four serpentine, yellowish slits; sides of plate very finely rugose. Button large, round, deep red. Spiracles located nearly the height of one plate above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 5.5 mm.; diameter, 2.5 mm.

26. HYPHANTROPHAGA HYPHANTRIAE Townsend.

Medium size; subshining, yellowish red. Spiracles shining black, very dark red in the center, slightly raised above the surface, widely separated, the space nearly equal to the width of one plate. Each plate has four serpentine, yellowish slits. The two bottom slits resemble the letter S, with a long tail. Spiracles located a little more the height of one plate above the longitudinal axis. Button rather large, round, flat, and reddish. Anal opening small, far below the spiracles.

Length, 6 mm.; diameter, 2.25 mm.

27. EXORISTA EUDRYAE Townsend (Oxexorista eudryae Townsend).

Medium size; rather shining, dark red. Spiracles shining black, slightly raised above the surface, widely separated, the space about equal to twice the width of one plate. Between and below the spiracles is a prominent, ridgelike elevation much higher than the stigmal plates. Each plate has three serpentine, yellowish slits. (Sometimes the two slits at the bottom are connected and form one long slit.) Button large, round, well defined. Anal opening large, far below the spiracles. Spiracles are located on the upper side of the longitudinal axis.

Length, 7 mm.; diameter, 3 mm.

NOTE.—In one specimen, on one plate only, the two bottom slits are united, showing only two slits instead of three.

28. FRONTINA FRENCHII Williston (Achaetoneura frenchii Williston).

Large; dull, deep red to nearly black. Spiracles only slightly raised above puparia; black on sides and yellowish red on upper surface; located about the width of one stigmal plate above the longitudinal axis and separated by a space nearly equal to width of one plate. Three serpentine slits to each stigmal plate and a well-defined button. Anal opening very remote, quite near the lower edge of the end view.

Length, 8.5 mm.; diameter, 4 mm.

29. LINNAEMYIA FULVICAUDA Walton (Gymnochaetopsis fulvicauda Walton).

Medium-sized; faintly rugose, dull reddish puparium. Spiracles slightly raised above surface, shiny black above and faintly granular around lower edge, located on longitudinal axis, mostly above, nearly touching above and more widely separated below. Each spiracle divided into three lobes, each lobe with a serpentine, nearly black slit. A distinct round button. At the bottom of and between the stigmal plates is a prominent, raised area which terminates in a

point on each side; a transverse depression in the middle of same. Anal opening small and located at the lowest fourth in the end view.

Length, 5.5 mm.; diameter, 2.25 mm.

30. FRONTINA ALETIAE Riley (Rileyella aletiae Riley). FRONTINA ARCHIPPIVORA Williston (Ypophaemyia malacosomae Townsend).

The puparia of these two species are almost identical; small, smooth, elliptical, dull, dark yellowish red. Spiracles slightly raised above surface of pupa, reddish black, located slightly above longitudinal axis, each having three serpentine slits. Button large, round, and near center of spiracular plate. Anal opening directly on center.

Length, 5.25 mm; diameter, 2 mm.

31. CLAUSICELLA TARSALIS Coquillett (Phylacteropoda tarsalis Coquillett).

Very small; subshining, yellowish red. Caudal end decidedly protuberant, smooth, dark red. On each side at the base of the tubercle is a large, blackish tubercle; above are two smaller tubercles, near the center; spiracles located on the apex of this large protuberance widely separated. Each plate is blackish, somewhat leaf-shaped, with five slits, each on a small ridge. Button large, round. Protuberance below the longitudinal axis, the upper edge at the base touching the axis line. Anal opening very small, some distance below the tubercle.

Length, 3 mm.; diameter, 1.5 mm.

32. TACHINOPHYTO TORTRICIS Coquillett (Tortriciophaga tortricis Coquillett).

Small; yellowish red, decidedly tuberculate on the posterior end. Spiracles very protuberant, nearly cylindrical, contiguous at the base, widely divergent at apex, shining black, with a roughened, granular band in the middle, located on top of a large tubercle the height of which is about half its diameter. Spiracular plates on top of the cylindrical protuberances. Each plate has five very small, reddish slits, each on top of a faintly defined ridge. Button large, round, fairly well defined, and near the center of the plate. Anal opening very small, far below the spiracles. Spiracles located far above the longitudinal axis.

Length, 4 mm.; diameter, 1.75 mm.

33. STURMIA PILATEI Coquillett.

Small; reddish yellow, subshining, and nearly straight on the ventral surface. Just below the apex of the posterior end is a faint depression, giving the posterior end a faint appearance of being a large tubercle. Spiracles are subshining, black, and faintly reddish in the center, widely separated, the space almost equal to the width of one plate. Each plate has three yellow slits, each on a broad,

poorly defined ridge. Button large, round, red, and with a faint depression in the center. Between the spiracles is an elongated depression, which is wider at each end. Spiracles located slightly below the longitudinal axis. And opening quite large, decidedly raised above the surface of the puparium, located far below the spiracles. Anterior spiracles small, tuberculate, and reddish.

Length, 5 mm.; diameter, 1.5 mm.

34. EXORISTA PYSTE Walker.

Medium size; shining, dark red; posterior end, in profile, slightly depressed dorsally and broadly rounded on the lower half. Stigmal plates shining black, slightly raised above the surface, separated by a space nearly equal to the width of one plate. Each plate has three dark-reddish slits, the upper and middle ones slightly arcuate, the middle and lower slits closer together. Button large, round, well defined. Spiracles located a short distance above the longitudinal axis. Anal opening very small, far below the spiracles.

Length, 6.75 mm.; diameter, 3 mm.

35. TACHINOPHYTO VARIABILIS Coquillett (Euzenillia variabilis Coquillett).

Small; subshining, yellow or red; posterior end tuberculate; tubercle located on lower half of puparium, viz, mostly below the longitudinal axis. Stigmal plates shining black, slightly raised above the surface and separated by a space nearly equal to the width of one plate. Each plate has three short slits, which are nearly straight; slits yellow, each located on a broad, slightly flattened, deep-reddish ridge. Button large, round, and located near the center of the stigmal plate. Spiracles located just below the longitudinal axis. Anal opening large, located far below the stigmal plates.

Length, 5 mm.; diameter, 1.75 mm.

36. TACHINOPHYTO FLORIDENSIS Townsend.

Small; dull, reddish yellow; posterior end tuberculate; bottom surface of puparium nearly straight. Spiracles shining black, widely separated, the space nearly equal to the width of one plate. Each plate has three slits, each located on top of a well-defined ridge. Button large, round. Spiracles located on a tubercle far below the longitudinal axis. Anal opening small, located below near the base of the large tubercle.

Length, 4.25 mm.; diameter, 1.25 mm.

37. PHORICHAETA CINEROSA Coquillett (Polideosoma cinerosa Coquillett).

Small; dull, dark yellowish red. Spirales shining black, narrowly separated and located on a very prominent, rugose protuberance, which is darker than the puparium. This protuberance is at an

oblique angle to the puparium from a lateral view. Each stigmal plate has three slits, each on top of a well-defined ridge. Button large, round. Spiracles located on longitudinal axis. Anal opening small, located just below the protuberance.

Length, 5 mm.; diameter, 2 mm.

38. ACTIA PILIPENNIS Fallén (Gymnophthalma pilipennis Fallén).

Small; shining, yellowish red; posterior end with a large tubercle. Spiracles shining, dark red, with a blackish tinge, especially around the base; plates touching; located on the large tubercle. Each plate has three slits, each located on top of a broad, well-defined ridge. Button large, round, not distinctly defined. Spiracles located slightly below the longitudinal axis. Anal opening small, just below the spiracles.

Length, 4 mm.; diameter, 1.75 mm.

39. SIPHONA GENICULATA De Geer (Crocuta illinoisensis Townsend).

Very small; dull, very dark red; posterior end narrowed down to a large tubercle, with the apex bilobed. Upon each lobe is located the spiracle or stigmal plate, which is black and subshining. These plates are separated by a distance equal to the length of one plate. Each plate has three small, yellowish slits. Button small, not very distinct. Spiracles located on longitudinal axis. Anal opening small, located at the base of the large tubercle.

Length, 4 mm.; diameter, 1.75 mm.

40. SIPHONA PLUSIAE Coquillett (Siphonopsis plusiae Coquillett).

Very small; dull, dark red; posterior end narrowed down to a large tubercle, upon which the spiracles are located. Spiracles small, dull black, slightly raised above the surface, widely separated, the space between equal to width of one plate. Each plate has three yellowish slits, nearly straight. Button large, not very well marked. Spiracles located on longitudinal axis. Anal opening small and far below the stigmal plates.

Length, 3.5 mm.; diameter, 1.5 mm.

41. PANZERIA PENITALIS Coquillett (Pyraustomyia penitalis Coquillett).

Medium size; elongate, subshining, yellowish red; bottom surface with a broad indentation; posterior end rather sharply tuberculate. Spiracles small, shining black, separated by a distance about equal to the width of one plate. Each plate has three slits, each located on a rather broad, flat ridge. Button large, round, well defined. Spiracles located on top of tubercle, which is mostly above the longitudinal axis. Anal opening small, located just below the tubercle.

Length, 7 mm.; diameter, 2 mm.

42. LESKIOMIMA TENERA Wiedemann.

Medium size; dull, yellowish red; posterior end tuberculate; tubercle bent slightly upward. Spiracles protuberant, shining black, about or nearly touching at the base. Stigmal plates widely separated by a V-shaped space between them. Each plate has three small, nearly straight slits, each located on a rounded, well-developed ridge, which is nearly round; upper and lower ridge higher and more developed than the middle one. Button large, round, located on the inner side of each plate. Anal opening large, located far below the spiracles. Spiracles located on but mostly above the longitudinal axis.

Length, 6 mm; diameter, 2 mm.

43. PARAPLAGIA SPINULOSA Bigot (Blepharigenia spinulosa Bigot).

Medium size; dull, nearly black; posterior end with a large round tubercle, the bottom of which is on the longitudinal axis. Spiracles shinging black, raised above the surface; stigmal plates touching. Each plate has three slits located on well-marked ridges. Button round, located on inner edge of plate, and well marked. Spiracles located on the large tubercle, above its center. Anal opening fairly large and far below the tubercle.

Length, 7 mm; diameter, 3.5 mm.

44. METACHAETA HELYMUS Walker.

Small; dull, dark yellowish red; posterior end slightly tuberculate, the apex of which is faintly depressed; spiracles shining reddish black, narrowly separated and located on the longitudinal axis. Each spiracle has three slits. Each slit is located on top of a small, well-defined ridge. Button round, well defined. Anal opening fairly large and at the base of the tubercle.

Length, 4.75 mm.; diameter, 1.75 mm.

45. ALOPHORA PULVEREA Coquillett (Oedematopteryx pulverea Coquillett).

Very small; dull, pale yellow; upper surface of puparium nearly straight, lower surface broadly rounded. Spiracles shining black, protuberant, conical, with a small, vertical groove on the apex between the stigmal plates. Each plate is long, narrow, slightly triangular, with three yellowish slits, each located on a well-defined ridge; the two inner slits rather long, the middle one much shorter. Button quite small. Anal opening small and reddish. Spiracles located slightly above the longitudinal axis.

Length, 3.5 mm.; diameter, 1.25 mm.

46. PHORANTHA OCCIDENTIS Walker (Phoranthella morrisoni Townsend).

Very small; dull, reddish yellow; sharply pointed on posterior end. Spiracles protuberant, shining black, faintly reddish along the apical edge and pointing downward. From above the spiracles are solid at the base, and the spiracular plates are well separated by a V-shaped space. Each plate is triangular in shape and has three slits, each on top of a well-defined reddish-yellow ridge; the upper slit the longest and the middle the shortest. Between the slits the surface is deep reddish. Button large, rounded, and reddish. Spiracles located on the longitudinal axis. Anal opening small, just below the spiracles.

Length, 2 mm.; diameter, 1 mm.

47. FRONTINA ANCILLA Walker (Frontiniella parancilla Townsend).

Small; subshining, dark red. Spiracles shining black, located on prominent protuberances, which are granular around the basal half, smooth on upper half. They are separated by a space equal to the length of one stigmal plate. Each plate has three small tubercles on the surface. On the top of each is located the slit. Button small, round, and rather weak. Spiracles located on the longitudinal axis. Anal opening small, located below about twice the length of the protuberance.

Length, 5 mm.; diameter, 1.75 mm.

48. CLYTIOMYIA FLAVA Townsend.

Small; dull red. Spiracles protuberant, shining black, roughly granular at the base. From above they are widely separated by a V-shaped space. Spiracles triangular, each having three faintly-yellow slits, each slit on top of a very well-defined ridge. Button round, well defined. Anal opening very small and quite close to spiracles. Spiracles located on the longitudinal axis.

Length, 5 mm.; diameter, 2.25 mm.

49. PLAGIA AMERICANA Van der Wulp.

Medium size; dull, dark red; posterior end of the puparia noticeably larger than the anterior end. Spiracles are decidedly protuberant, shining black, touching at the base and widely divergent at the apex. The bases of these protuberances are covered with small spines. Stigmal plates on top of the protuberances. Each plate has three small slits, each on top of a well-defined ridge. Anterior spiracles well developed, shining black, tuberculate, and widely separated. Button large, located on the inner edge of the plate. Anal opening small, far below the spiracles, and slightly below the longitudinal axis. Spiracles located far above the longitudinal axis.

Length, 6.25 mm.; diameter, large, 3 mm.; small, 2 mm.

50. ACEMYIA DENTATA Coquillett (Acemyiopsis dentata Coquillett).

Medium size; dull, blackish red, very finely rugose; posterior end slightly tuberculate. Spiracles black, protuberant, touching at the base; apex separated by a space nearly equal to the width of one plate; the sides roughly granular; apex shining, divided into three lobes. The slits are yellowish and located on these lobes. Button large and round. Spiracles located above on the longitudinal axis. Anal opening located below, about the length of one stigmal plate.

Length, 6 mm.; diameter, 2.75 mm.

51. EUTRIXA EXILE Coquillett.

Medium size; shining, dark red; posterior end greatly enlarged; anterior half of the dorsum with a deep depression. Spiracles black, on small tubercles, which have a granular surface. Spiracles widely separated, the distance nearly equal to twice the basal diameter of the tubercles. Each stigmal plate has three slits, each one of which is on top of a sharply defined ridge. Button small, round, located on upper edge. Spiracles located far above longitudinal axis. Anal opening large, located just below the longitudinal axis.

Length, 7 mm.; diameter, 2.75 mm.

52. PHOROCERA ERECTA Coquillett.

Medium-sized; subshining, yellowish red. Spiracles shining, mostly dark, yellowish red, blackish around the edge, widely separated, the space equal to about three-fourths the width of one plate. Each plate has four slits. The three upper ones are concaved and the lower slit convex. Each slit on top of a broad, yellow, flat ridge. Button very large, round, reddish yellow. Spiracles are located very slightly above the longitudinal axis. Anal opening large, far below the spiracles.

Length, 5.5 mm.; diameter, 2 mm.

53. CRYPTOMEIGENIA THEUTIS Walker.

Medium to large size; dull, dark red; concave on the dorsum; spiracles shining black, distinctly raised above the surface, well separated, the space equal to the width of one plate. Each plate has six (rarely five) nearly straight, deep-yellow slits. Button large, round, well defined. Spiracles located above the longitudinal axis, a little more than the length of one stigmal plate. Anal opening large, far below the spiracles.

Length, 6.5 to 9 mm.; diameter, 2.75 to 4.5 mm.

54. BIOMYIA LACHNOSTERNAE Townsend (Viviania lachnosternae Townsend).

Medium size; subshining, dark red; posterior end much larger diameter than the anterior end. Spiracles shining black, slightly

raised above the surface, narrowly separated by a space about one-fourth the width of one plate. Each plate has six small, slightly angular, yellowish slits on a flattened surface. Button large, round, near inner edge. Anal opening small, far below the spiracles. Spiracles located little more than the length of one plate above the longitudinal axis.

Length, 7 mm.; diameter, large, 3.65 mm.; small, 2.5 mm.

55. CRYPTOMEIGENIA AURIFACIES Walton.

Medium size; dull, dark red; surface of puparium roughened or granular to nearly rugose; caudal end much larger in diameter. Stigmal plates shining black, widely separated, space equal to width of one plate. Each plate is flattened on the dorsal surface and deep reddish to black. Each plate has six yellowish slits, which are nearly straight. Some specimens show the slits more angulated than shown in the drawing. Button large, round. Anal opening large, located far below the stigmal plates. Spiracles located far above the longitudinal axis.

Length, 6.5 mm.; diameter, 3 mm. at largest diameter.

56. HYALOMYODES TRIANGULIFERA Loew.

Very small; dull, yellowish red; a depression on the dorsum of the anterior half; segmental lines of the last three or four segments plainly seen on the dorsum. Spiracles shining black, narrowly separated at the base; slightly raised above surface. Each stigmal plate has three very small, yellowish slits. Button small, not very plainly seen. Spiracles located on longitudinal axis. Anal opening small, far below the spiracles.

Length, 3 mm.; diameter, 1.4 mm.

Some puparia do not have the segmental lines and the dorsal depression.

57. ADMONTIA HYLOTOMAE Coquillett (Hylotomomyia hylotomae Coquillett).

Medium-sized; subshining, red to reddish yellow. Spiracles shining black, slightly raised above the surface, widely separated, space equal to one-half of one plate; each plate with three yellowish slits, each located on top of a well-defined ridge. Button reddish, prominent, rather quadrate in shape. Spiracles far above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 7 mm.; diameter, 3 mm.

58. MASICERA, species (near EXILIS).

Medium-sized; dull yellow; somewhat pointed on posterior end Spiracles shining black, slightly raised above the surface and separated by a very narrow space at the bottom. Each plate has three slits, each on top of a well-defined ridge; slits yellowish red. Button

large, prominent, and red. Spiracles located a short distance above the longitudinal axis. Anal opening small, reddish, located some distance below the spiracles.

Length, 5.5 mm.; diameter, 2 mm.

59. FRONTINA ARMIGERA Coquillett (Eucelatoria armigera Coquillett).

Small; dull, yellowish red. Spiracles shining black, slightly raised above the surface, separated by a space equal to one-half the width of one plate. Each plate has three reddish slits, each on top of a well-defined ridge. Button large, round, prominent, extending beyond the edge of the plate. Spiracles located some distance above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 6 mm.; diameter, 2.25 mm.

60. AMOBIA CONFUNDENS Townsend (Amobiopsis confundens Townsend).

Medium-sized; subshining, dark red; posterior end distinctly rugose. Spiracles black, subshining, slightly raised above the surface, widely separated by a space equal to about one and one-half times the width of one spiracular plate. Each plate has three broad, yellowish slits nearly parallel and depressed along the center, each on a distinct ridge. Button small, round. Anal opening small, far below the spiracles. Spiracles located just above the longitudinal axis.

Length, 7.25 mm.; diameter, 3 mm.

61. EXORISTA AMPLEXA Coquillett (Masiceropsis amplexa Coquillett).

Large; dull, dark red. Spiracles about flush with the surface of the puparium, in a faint triangular depression. Spiracles shining black, well separated; three slits reddish. Button round. Just below the spiracles is a broad tubercle. Spiracles located on longitudinal axis. Anal opening far below the spiracles. Posterior end of puparium around the stigmal area is rugose.

Length, 10 mm.; diameter, 4 mm.

62. CHAETOGAEDIA ANALIS Van der Wulp.

Very large; cylindrical, dull, dark red, darker on caudal end. Slightly but broadly constricted on the dorsum near posterior end. Caudal end rather blunt. Spiracles decidedly raised, shining black, and each formed into three well-defined lobes, and each lobe with a well-defined slit on the dorsal ridge; the inner and outer slit with an indentation at the middle. Button well defined. Spiracles located on longitudinal axis and separated by a space about equal to the inner lobe. Anal opening located at about the lowest fourth of the end view.

Length, 10 mm.; diameter, 4 mm.

63. ARCHYTAS ANALIS Fabricius.

Large; dull, dark red, with a faint indication of a depression or stricture near the posterior end. Spiracles shining black, slightly raised above the surface, separated by a space nearly equal to the width of one plate. Each plate has three slits, each located on top of a well-defined ridge. Button fairly large, round. Spiracles above longitudinal axis, about two-thirds the width of one plate. Anal opening very small, far below the spiracles.

Length, 10.5 mm.; diameter, 4.75 mm.

64. ARCHYTAS HYSTRIX Fabricius (Jurinopsis floridensis Townsend).

Very large; cylindrical, dull, dark red; constricted near the caudal end, forming a distinct lobe or segment at the end of the puparium, which is much larger at the base. Spiracles shining black, well raised, and on longitudinal axis; three reddish-yellow slits, each located along the upper edge of a well-defined ridge. Button round, well defined. Spiracles separated by a distance nearly equal to the width of one spiracle. Anal opening down near lower edge of end view.

Length, 14 mm.; diameter, 6 mm.

65. ARCHYTAS LATERALIS Macquart (Makasinocera lateralis Macquart).

Large; subshining, dark red, rugose, upper surface nearly flat; posterior end flattened on the upper half. Spiracles shining black, located above the longitudinal axis a distance about equal to the width of one plate. Each plate has three slits, each on top of a well-defined ridge. Button small, round. Anal opening small, far below the spiracles.

Length, 12.5 mm.; diameter, 5.75 mm.

66. GONIA CAPITATA De Geer.[3]

Large; dull, dark red. Spiracles shining black, slightly raised above the surface, separated by a space equal to one-half the width of one plate. Each plate has three slits, each on top of a well-defined ridge. Button round, well defined. Spiracles located just above the longitudinal axis. Anal opening small, far below the stigmal plates.

Length, 10 mm.; diameter, 4.25 mm.

67. GONIA EXUL Williston.

Large; dull, dark red. Spiracles shining black, decidedly raised above the surface, widely separated at the base, the distance equal to about one-half to two-thirds the width of one plate. Each plate has three slits, black, each located on top of a very well-defined

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[3] The adult, a female, has the characters of *Gonia sequax* Williston.

ridge. Button large, round. Spiracles slightly above the longitudinal axis. Anal opening large, far below the spiracles.

Length, 10.5 mm.; diameter, 4.75.

68. BLEPHARIPEZA ADUSTA Loew (Rileymyia adusta Loew).

Large; dull, dark red. Spiracles black, shining, slightly raised above the surface. Stigmal plates separated by a distance equal to about one-third the width of one plate. Each plate has three reddish slits, each at the top of a well-defined ridge. Button large, round. Spiracles above, almost on the longitudinal axis. Anal opening small, far below the spiracles. Just below the stigmal plates is a somewhat diamond-shaped elevation with a median depression.

Length, 8 mm.; diameter, 4.5 mm.

69. MASICERA EUFITCHIAE Townsend (Phrynolydella eufitchiae Townsend).

Very large; dull, dark red, very finely rugose. Spiracles shining black, slightly raised above the surface, separated by space nearly equal to the width of one stigmal plate. A small indentation just above and between the stigmal plates and one below each plate. Below the spiracles is a transverse elongated elevation with an elongated, central depression. Spiracles located on longitudinal axis. Anal opening small, far below the spiracles.

Length, 9.5 mm.; diameter, 4.5 mm.

70. LINNAEMYIA COMTA Fallén (Bonnetia comta Fallén).

Large; dull, reddish yellow. Spiracles shining black, slightly raised above the surface, widely separated, the space nearly equal to one-half the width of one plate. Each plate has three curved slits, each on top of a well-defined ridge. Button large, round. An elongated ridge extending up between the plates, larger and broader at the base. Spiracles far above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 10 mm.; diameter, 4 mm.

71. PELETERIA ROBUSTA Wiedemann (Sphyromyia robusta Wiedemann).

Very large; robust, dull, dark red. Spiracles shining black, decidedly raised above the surface of the puparium. Stigmal plates well separated; space between them nearly equal to the width of one plate. Each plate has three long slits, each slit on a large, well-defined ridge. Two upper slits are nearly parallel; the upper one is horizontal. Button large, round, flat. Anal opening large, located far below the spiracles. Spiracles located just above the longitudinal axis.

Length, 11.5 mm.; diameter, 5 mm.

72. TACHINA MELLA Walker (Exorista mella Walker).

Small; dull, yellowish red. Spiracles subshining, slightly raised above the surface, separated by a distance equal to about one-half of one plate. Each plate has three reddish slits, each on a well-defined ridge. Button large, round, and reddish. Just below the spiracles is a prominent elevation with an indentation in the center. Spiracles located slightly above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 5 mm.; diameter, 2 mm.

73. EUPHOROCERA CLARIPENNIS Macquart (Neophorocera claripennis Macquart).

Small to large; dull, light red to very dark red, slightly lighter red above and between the spiracles. Spiracles shining black, widely separated, the space nearly equal to the height of one plate. Each plate has three dark-yellow slits, each on top of a well-defined ridge. Button large, round. Spiracles located on the upper side of the longitudinal axis. Below and between the spiracles is a large, dark, rugose elevation with a central depression. Anal opening small, far below the spiracles.

Length, 5 to 8 mm.; diameter, 2 to 4 mm.

74. HYPOCHAETA LONGICORNIS Schiner.

Very small; dull yellowish red. Spiracles black, faintly shining, narrowly separated, slightly raised above the surface. Each plate with three slits, each slit located on a rather flattened, faint ridge. Button large, somewhat elliptical. Anal opening small, located nearly twice the length of one plate, below the stigmal plates. Spiracles located slightly above the longitudinal axis.

Length, 3.5 mm.; diameter, 1.5 mm.

75. PHOROCERA TORTRICIS Coquillett.

Very small; dull, reddish yellow. Spiracles shining black, slightly raised above the surface, separated by a space equal to about one-third the width of one plate. Each plate has three yellowish slits, each located on a well-marked ridge. Button round, well marked. Between, at the base of the stigmal plates, is an elevation nearly as large as one stigmal plate. The sides of the elevation are brownish, and it is pointed on the upper edge. Spiracles located on longitudinal axis. Anal opening small, quite far below the stigmal plates.

Length, 3.75 mm.; diameter, 1.25 mm.

76. PHORICHAETA SEQUAX Williston (Polideosoma sequax Williston).

Small; dull, yellowish red. Posterior end of puparium faintly tuberculate. Spiracles reddish, located on this faint tubercle. Each spiracle has three slits, each slit on top of a ridge; spiracles nearly

touching and located on the longitudinal axis. Button large, round, close to inside edge. Anal opening small, remote from spiracles.

Length, 3.75 mm.; diameter, 1.5 mm.

77. DICHAETONEURA LEUCOPTERA Johnson.

Medium size; subshining, yellowish red. Spiracles black, subshining, separated by a space equal to about one-third the width of one plate. Each plate has three short slits toward the outer edge, each on a very narrow, poorly defined ridge. Button large, round, somewhat indistinct. Spiracles located below the longitudinal axis, but just about touching it. Anal opening very small, far below the spiracles.

Length, 6 mm.; diameter, 2 mm.

78. TACHINA RUSTICA Meigen (Exorista simulans Meigen).

Small to medium; dull, yellowish red. Spiracles shining black, red in the center, widely separated, space nearly equal to width of one plate. Each plate has three yellowish slits, each on top of a well-defined ridge. Button large, round, and blackish. Spiracles very slightly above the longitudinal axis. Between the spiracles, at the pole, is a diamond-shaped elevation with a depression in the center. Anal opening small, far below the spiracles.

Length, 5 to 6.5 mm.; diameter, 2 to 2.5 mm.

79. TACHINA ROBUSTA Townsend (Tachinomyia robusta Townsend).

Medium to large size; dull, reddish to nearly black, finely rugose. Spiracles shining black, widely separated, space nearly equal to width of one plate. Each plate has three reddish-yellow slits, each slit on top of a well-defined ridge, which is striated; inner slit noticeably larger than the other two. Spiracles far above the longitudinal axis. Area around the spiracles with larger rugosities. Anal opening small, far below the spiracles.

Length, 6.5 to 12 mm.; diameter 3 to 5.5 mm.

80. MASICERA MYOIDEA Desvoidy.

Medium-sized; dull, dark red, with a grayish tinge, nearly smooth. Spiracles shining black, slightly raised above the surface, separated by a distance equal to about one-half of one plate. Each plate has three slits. Button small, round, well defined. Spiracles located on longitudinal axis. Anal opening small, far below the spiracles.

Length, 7.5 mm.; diameter, 3 mm.

81. STURMIA NIGRITA Townsend.

Medium size, elongate; dull, dark red. Spiracles black, subshining, slightly raised above surface, separated by a distance equal to one-half the width of one stigmal plate. Each plate has three

yellowish slits. Button small, round. Spiracles located just above the longitudinal axis. Anal opening small, located far below the stigmal plates.

Length, 8.5 mm.; diameter, 3 mm.

82. FRONTINA TENTHREDINIDARUM Townsend (Myrsina tenthredinidarum Townsend).

Small; dull, yellowish red. Spiracles shining black, slightly reddish in the middle, slightly raised above the surface, widely separated by a space nearly equal to the width of one plate. Each plate has three yellowish slits, each on top of a narrow ridge. Button small, rounded, and not very distinct. Spiracles located very slightly above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 5 mm.; diameter, 2 mm.

83. EXORISTA NIGRIPALPIS Townsend.

Small; subshining, yellowish red. Spiracles shining, black around the edge, reddish, in the center, slightly raised above the surface. Each plate has three reddish-yellow slits, each on top of a poorly defined ridge. Button large, round, deep red. Spiracles located slightly above the longitudinal axis. Anal opening fairly large, far below the spiracles.

Length, 5 mm.; diameter, 2 mm.

84. EXORISTA GRISEOMICANS Van der Wulp (Masiceropsis amplexa Coquillett).

Medium-sized; subshining, dark red. Spiracles shining black, dark reddish in center, slightly raised above the surface. Each plate has three reddish slits, each on top of a broad, flattened, indistinct ridge. Button large, round, deep red. Spiracles located some distance above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 6 mm.; diameter, 3 mm.

85. PHOROCERA FLAVICAUDA Van der Wulp.

Medium size; subshining, yellowish red; broadly rounded posteriorly, faintly depressed on the anterior dorsal portion. Spiracles black, subshining on the sides, deep reddish in the middle, slightly raised above the surface, widely separated, space equal to about one-half the width of one plate. Each plate has three reddish-yellow slits, the two lower slits closer together. Button large, round, reddish, slightly blackish near the middle. Spiracles located above the longitudinal axis slightly more than the height of one plate. Anal opening very small, far below the spiracles.

Length, 7.5 mm.; diameter, 2.75 mm.

86. PANZERIA RADICUM Fabricius (Varichaeta aldrichi Townsend).

Medium-sized; dull red, with a very faint depression on the dorsal surface. Spiracle dull black, very small, separated by a space nearly equal to the width of one plate, very slightly raised above the surface. Each plate has three very small slits, each on top of a faintly raised surface. Button large and round. Spiracles some distance above longitudinal axis. Anal opening small, far below the spiracles.

Length, 6 mm; diameter, 2.25 mm.

87. ZELIA, species (near GENUINA).

Medium size; subshining, rugose, especially on the posterior end. Spiracles subshining, black, decidedly raised above the surface, narrowly separated at the base, more widely so at the apex. Each plate has three dull-yellow slits, each slit located on top of a broad, well-defined ridge. Button small, round, depressed. Spiracles located only a short distance above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 7.5 mm.; diameter, 2.75 mm.

88. EXORISTA, species (Hopk. U. S. 13675*b*).

Medium-sized; subshining, dark red; caudal end slightly depressed dorsally at about one-third the length from the end. Spiracles shining black, widely separated, the space equal to the width of one plate. Each plate has three reddish slits, each on top of a well-defined ridge, the upper one much longer than either of the other two. Button red, large, well defined. A prominent elevation just below and between the spiracles. Anal opening large, far below the spiracles, on the flat under surface of the puparium. Spiracles located just below the longitudinal axis.

Length, 6.5 mm.; diameter, 2.65 mm.

89. MASICERA RUTILA Meigen.

Medium-sized; dull, yellowish red. Spiracles shining black, raised above the surface. Each plate has three reddish slits, each located on a well-defined ridge. Stigmal plates separated by a distance equal to about one-fifth of one plate. Button large, round. Spiracles just slightly above the longitudinal axis. Just below the stigmal plates is a broadly rounded, flattened tubercle with a depression near the apex. Anal opening small, far below the spiracles.

Length, 6.25 mm.; diameter, 2.75 mm.

90. ADMONTIA DEMYLUS Walker (Spathimeigenia spinigera Townsend).

Medium-sized; dull, reddish yellow. Spiracles shining black, slightly raised above the surface, narrowly separated, the space equal to about one-third the width of one plate. Each plate has three

yellow slits, each located on a well-defined ridge. Button large, round, red. Spiracles located a short distance above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 7 mm.; diameter, 2.75 mm.

91. PHOROCERA, species (near MACRA).

Medium-sized; subshining. Stigmal plates shining black, slightly raised above surface. Plates separated by a space equal to one-half of one plate. Each plate has three red slits, each on top of a ridge. Button round, fairly distinct. Spiracles located on longitudinal axis. Between and partly below the stigmal plates is a large, rugose tubercle. Anal opening small, far below the spiracles.

Lenth, 7 mm.; diameter, 2.75 mm.

92. PANZERIA AMPELUS Walker (Varichaeta ampelus Walker).

Medium-sized; dull, dark red, very minutely rugose. Spiracles shining black, slightly raised above the surface, separated by a space equal to one-third of one stigmal plate. Each plate has three reddish slits. Button medium-sized, round. Spiracles located on longitudinal axis. Just below the spiracles is a transverse, diamond-shaped elevation with a median depression.

Length, 7.5 mm.; diameter, 2.5 mm.

93. EXORISTA FUTILIS Osten Sacken (Euexorista futilis Osten Sacken).

Medium-sized; dull, dark red. Spiracles shining black, slightly raised above the surface, divided by a space nearly equal to one-half of one stigmal plate; area between plates smooth and shining. Each stigmal plate has three slits, each of which are located on a well-defined ridge. Button round, well defined. Spiracles located on the longitudinal axis. Anal opening small, far below spiracles.

Length, 8 mm.; diameter, 3.75 mm.

94. PHOROCERA CLARIPENNIS Macquart (Euphorocera tachinomoides Townsend).

Large; dull, dark red. Spiracles black, subshining, slightly raised above the surface, widely separated, the space between equal to about one-half the width of one plate. Each plate has three dark-red slits, each located on top of a well-defined groove. Button round, reddish, rather well defined. Spiracles located above the longitudinal axis, a distance about equal to the length of one plate. At the base and between the spiracular plates is a rugose, rounded, blackish elevation with a central depression. Anal opening small, far below the spiracles.

Length, 8 mm.; diameter, 3.5 mm.

95. WINTHEMIA QUADRIPUSTULATA Fabricius.

Medium size; dull, dark red. Spiracles shining black, faintly raised above the surface; stigmal plates separated by a distance equal to one-half of one stigmal plate. Each plate has three slits, each on top of a faint elevation. Spiracles just above the longitudinal axis. Button large, round. Anal opening small, far below the longitudinal axis.

Length, 8 mm.; diameter, 3 mm.

96. UROMACQUARTIA HALISIDOTAE Townsend.

Medium size, elongated; dark red and subshining. Spiracles shining black, narrowly separated and located on horizontal axis. Three slits, each on top of a well-defined ridge. Button small, round, located near inner edge. Anal opening far below spiracles.

Length, 9 mm.; diameter, 3.5 mm.

97. TRICHOPHORA RUFICAUDA Van der Wulp (Copecrypta ruficauda Van der Wulp).

Medium sized; dull, dark red. Spiracles shining black, tuberculate, separated by a distance nearly equal to the width of one stigmal plate. Three slits, each located on a well-defined ridge. Button small, round. Spiracles located on longitudinal axis. Anal opening far below the spiracles.

Length, 8 mm.; diameter, 3 mm.

98. STURMIA OCCIDENTALIS Coquillett.

Small; dull, reddish yellow; posterior end finely rugose. Spiracles shining black, slightly raised above the surface, widely separated, space equal to about one-third the width of one plate. Each plate has three reddish slits, each located on top of a well-defined ridge. Button fairly large, black, rounded. Spiracles located less than their own height above the longitudinal axis. Anal opening small, far below the spiracles.

Length, 5 mm.; diameter, 1.75 mm.

99. STURMIA ALBIFRONS Walker (Gymnocarcelia ricinorum Townsend).

Medium size; dull, dark red. Spiracles shining black, faintly raised above the surface, widely separated, the space equal to one-half the width of one plate. Each plate has three dark-yellow slits. The two outer slits form a U, and the middle one is oblique. Button large, round. Below the spiracles is a large, dark, rugose elevation with a central depression. Anal opening small, far below the spiracles. Spiracles located a short distance above the longitudinal axis.

Length, 8.5 mm.; diameter, 4 mm.

EXPLANATION OF PLATES.

Figures 1, 2, 3, 5, 11, 12, 14, 15. 16, 17, 19, 24, 25, 26, 29, 30, 42, 43, 44, 49, 50, 51, 52, 55, 68, 70, 71, 72, 73, 74, 77, and 95 were drawn by Mr. W. R. Walton. All the other figures were drawn by Mr. C. T. Greene. All drawings read from left to right.

PLATE 1.

FIG. 1. *Sturmia sociabilis* Greene.
2. *Sturmia distincta* Wiedemann.
3. *Phorocera mcracanthae* Greene.
4. *Sturmia inquinata* Van der Wulp.
5. *Celatoria diabroticae* Schiner.

PLATE 2.

FIG. 6. *Ptilodexia tibialis* Desvoidy.
7. *Hilarella siphonina* Zetterstedt.
8. *Pachyophthalmus floridensis* Townsend.
9. *Megapriopsis opaca* Coquillett.
10. *Zelia vertebrata* Say.

PLATE 3.

FIG. 11. *Beskia aelops* Walker.
12. *Oestrophasia ochracea* Bigot.
13. *Phasmophaga antennalis* Townsend.
14. *Coquillettina plankii* Walton.

PLATE 4.

FIG. 15. *Latreillemyia bifasciata* Fabricius.
16. *Leucostoma atra* Townsend.
17. *Microphthalma disjuncta* Wiedemann.
18. *Exorista lobeliae* Coquillett.

PLATE 5.

FIG. 19. *Gymnosoma fuliginosa* Desvoidy.
20. *Ocyptera carolinae* Desvoidy.
21. *Exorista confinis* Fallén.
22. *Trichopoda pennipes* Fabricius.
23. *Trichopoda lanipes* Fabricius.

PLATE 6.

FIG. 24. *Neopales saundersii* Williston.
25. *Exorista boarmiae* Coquillett.
26. *Hyphantrophaga hyphantriae* Townsend.
27. *Exorista eudryadis* Townsend.
28. *Frontina frenchii* Williston.

PLATE 7.

FIG. 29. *Linnaemyia fulvicauda* Walton.
30. *Frontina aletiae* Riley; *Frontina archippivora* Williston.
31. *Clausicella tarsalis* Coquillett.
32. *Tachinophyto tortricis* Coquillett.
33. *Sturmia pilatei* Coquillett.

PLATE 8.

FIG. 34. *Exorista pyste* Walker.
35. *Tachinophyto variabilis* Coquillett.
36. *Tachinophyto floridensis* Townsend.
37. *Phorichaeta cinerosa* Coquillett.
38. *Actia pilipennis* Fallén.

PLATE 9.

FIG. 39. *Siphona geniculata* De Geer.
40. *Siphona plusiae* Coquillett.
41. *Panzeria penitalis* Coquillett.
42. *Leskiomima tenera* Wiedemann.
43. *Paraplagia spinulosa* Bigot.

PLATE 10.

FIG. 44. *Metachaeta helymus* Walker.
45. *Alophora pulverea* Coquillett.
46. *Phorantha occidentis* Walker.
47. *Frontina ancilla* Walker.
48. *Clytiomyia flava* Townsend.

PLATE 11.

FIG. 49. *Plagia americana* Van der Wulp.
50. *Acemyia dentata* Coquillett.
51. *Eutrixa exile.* Coquillett.
52. *Neopales erecta* Coquillett.

PLATE 12.

FIG. 53. *Cryptomeigenia theutis* Walker.
54. *Biomyia lachnosternae* Townsend.
55. *Cryptomeigenia aurifacies* Walton.
56. *Hyalomyodes triangulifera* Loew.
57. *Admontia hylotomae* Coquillett.

PLATE 13.

FIG. 58. *Masicera*, species (near *exilis*).
59. *Frontina armigera* Coquillett.
60. *Amobia confundens* Townsend.
61. *Exorista amplexa* Coquillett.
62. *Chaetogaedia analis* Van der Wulp.

PLATE 14.

FIG. 63. *Archytas analis* Fabricius.
64. *Archytas hystrix* Fabricius.
65. *Archytas lateralis* Macquart.
66. *Gonia capitata* De Geer.

PLATE 15.

FIG. 67. *Gonia exul* Williston.
68. *Blepharipeza adusta* Loew.
69. *Masicera eufitchiae* Townsend.
70. *Bonnetia (Linnaemyia) comta* Fallén.
71. *Peleteria robusta* Wiedemann.

PLATE 16.

FIG. 72. *Tachina mella* Walker.
73. *Phorocera claripennis* Macquart.
74. *Hypochaeta longicornis* Schiner.
75. *Neopales tortricis* Coquillett.
76. *Phorichaeta sequax* Williston.
77. *Dichaetoneura leucoptèra* Johnson.

PLATE 17.

FIG. 78. *Tachina simulans* Meigen.
79. *Tachina robusta* Townsend.
80. *Masicera myoidea* Desvoidy.
81. *Sturmia nigrita* Townsend.
82. *Frontina tenthredinidarum* Townsend.

PLATE 18.

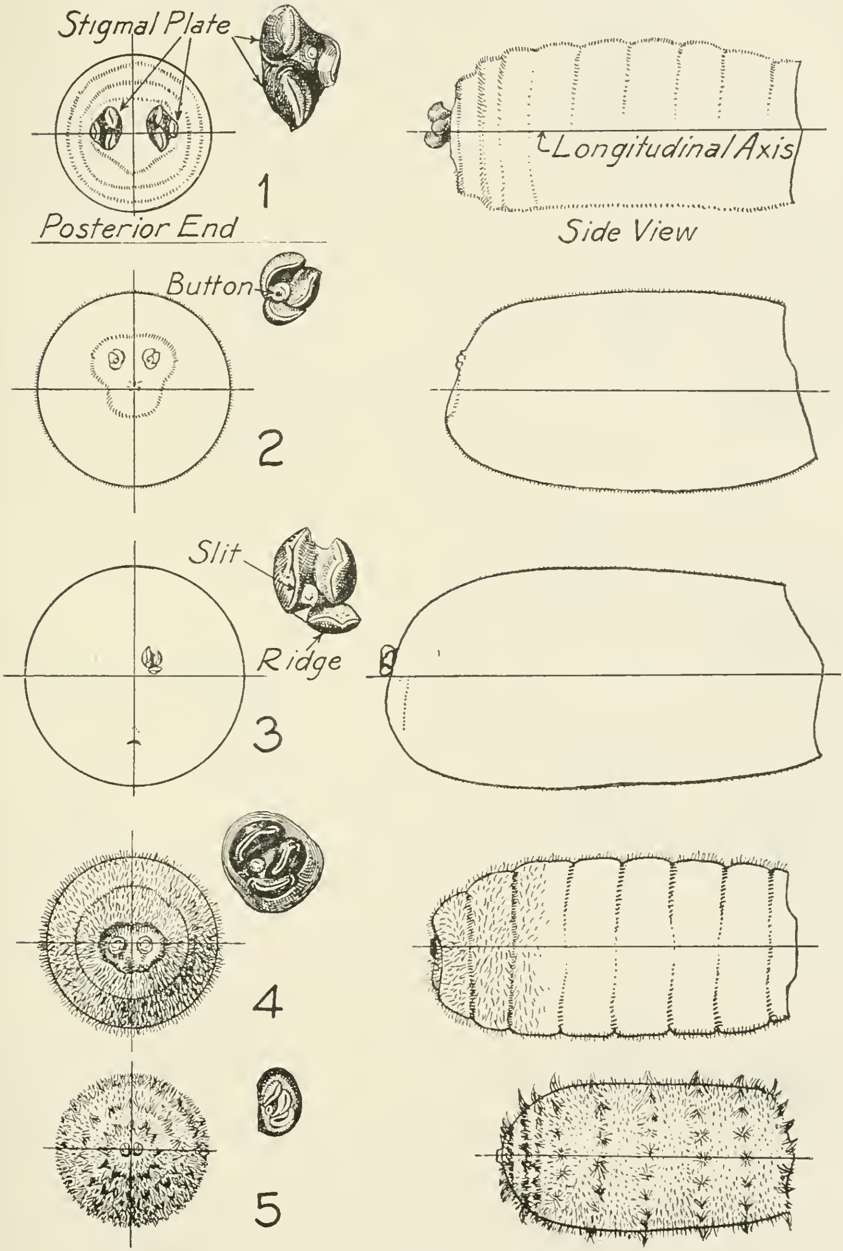
FIG. 83. *Exorista nigripalpis* Townsend.
84. *Exorista griseomicans* Van der Wulp.
85. *Neopales flavicauda* Van der Wulp.
86. *Panzeria radicum* Fabricius.
87. *Zelia*, species (near *genuina*).

PLATE 19.

FIG. 88. *Exorista*, species (13675*b*).
89. *Masicera rutila* Meigen.
90. *Spathimeigenia spinigera* Townsend.
91. *Phorocera* species (near *macra*).
92. *Varichaeta amplexa* Townsend.
93. *Exorista futilis* Osten Sacken.

PLATE 20.

FIG. 94. *Phorocera tachinomoides* Townsend.
95. *Winthemia quadripustulata* Fabricius.
96. *Uromacquartia halisidotae* Townsend.
97. *Cuphocera ruficauda* Van der Wulp.
98. *Sturmia occidentalis* Coquillett.
99. *Sturmia albifrons* Walker.



PUPARIA OF MUSCOID FLIES.

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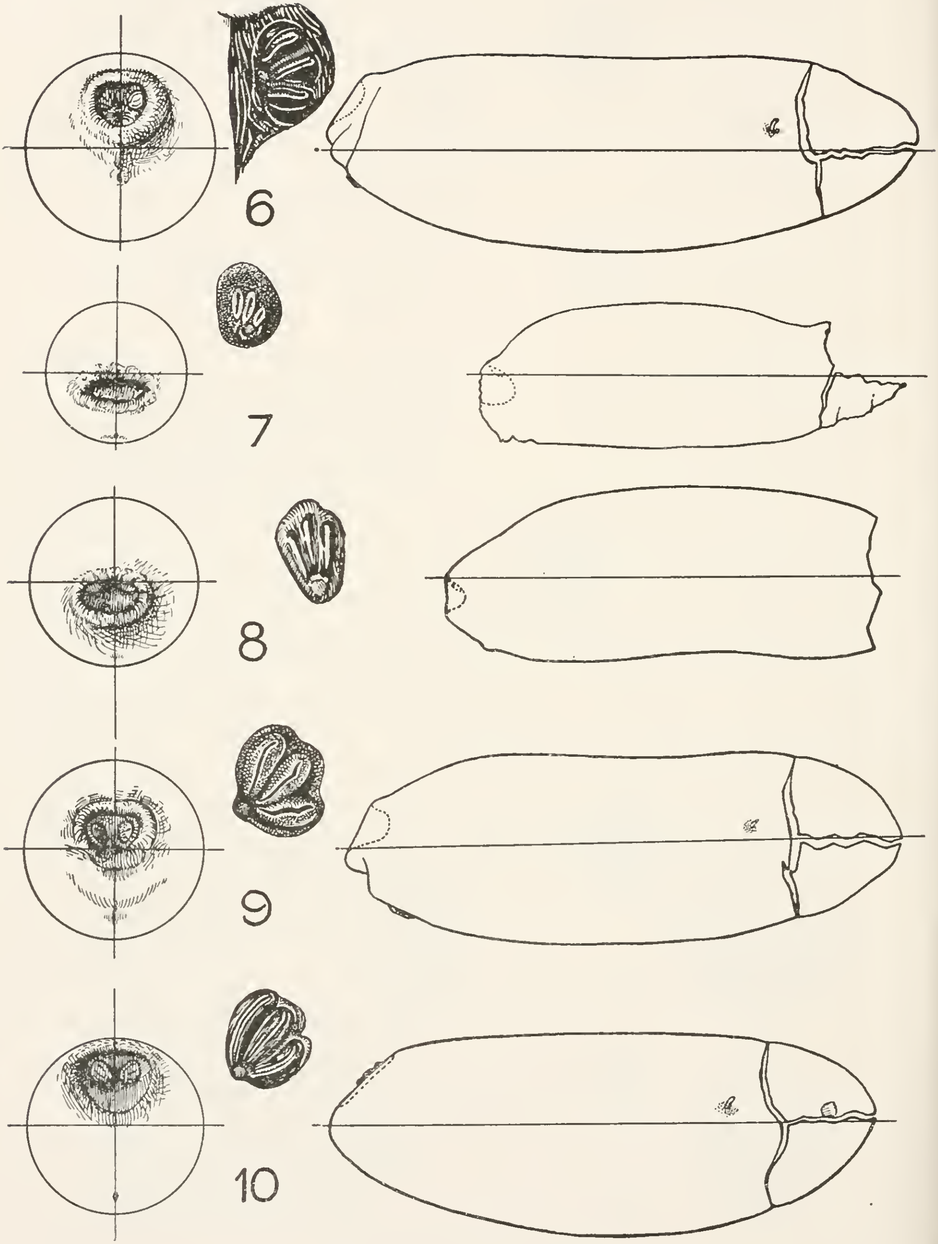

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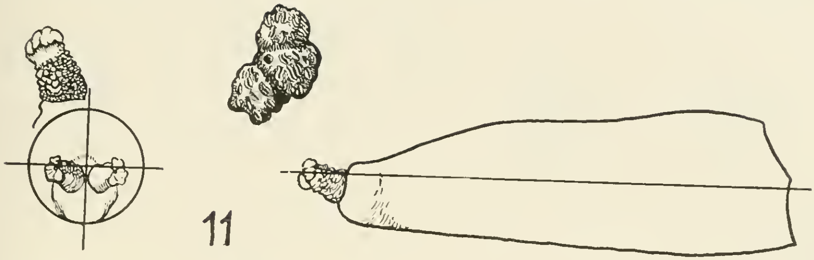

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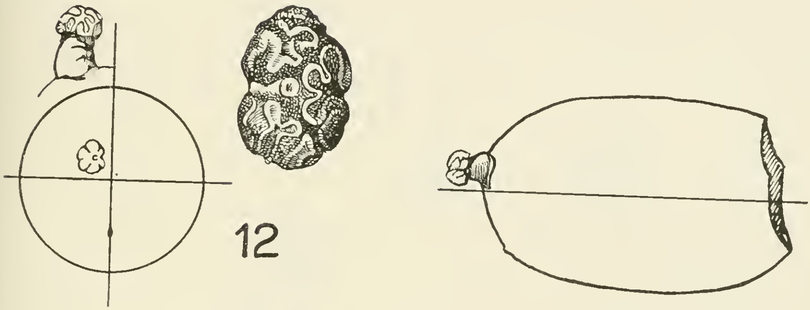

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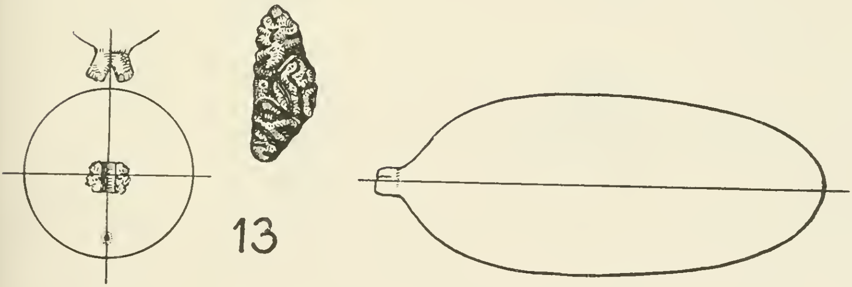

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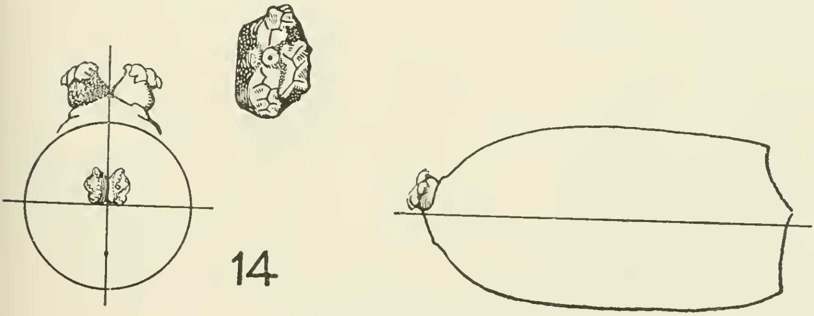

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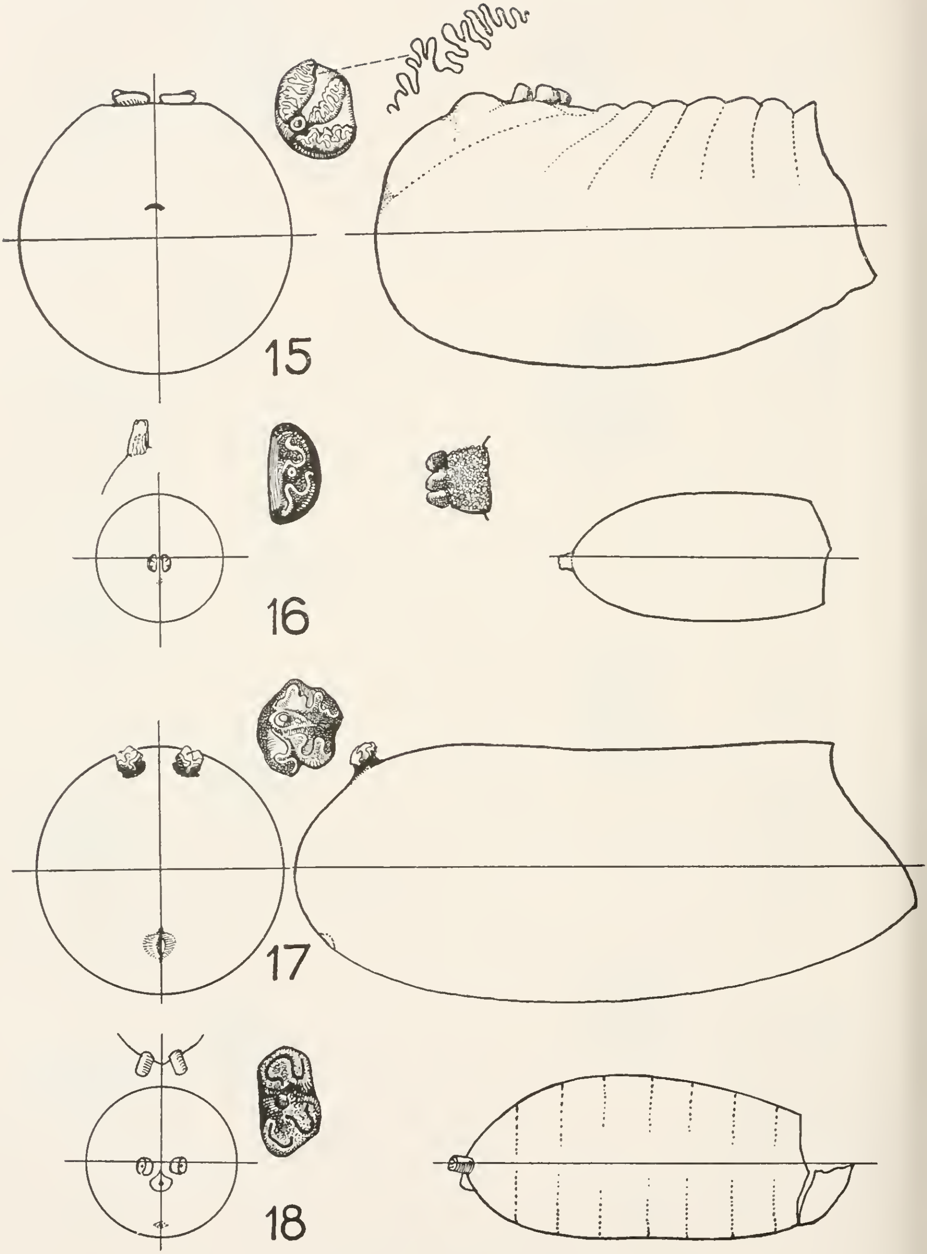

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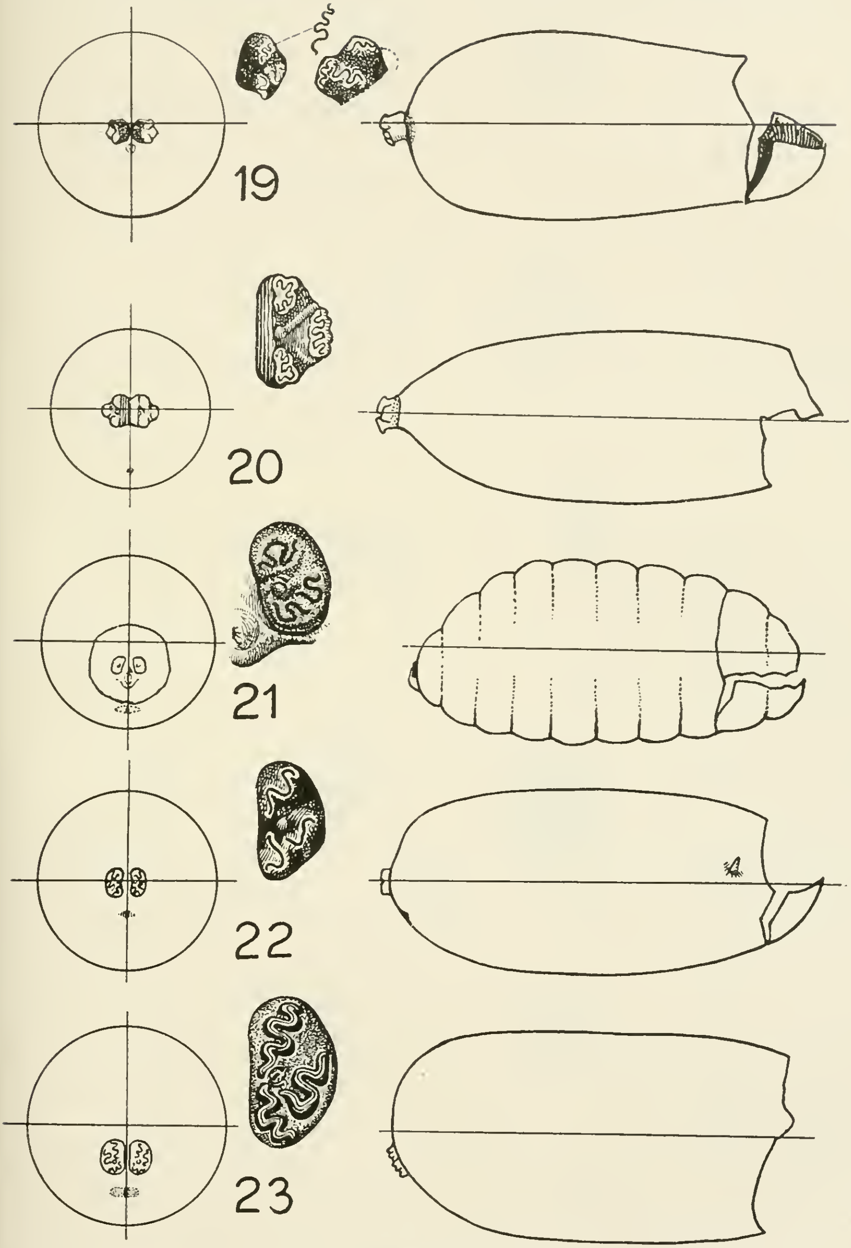

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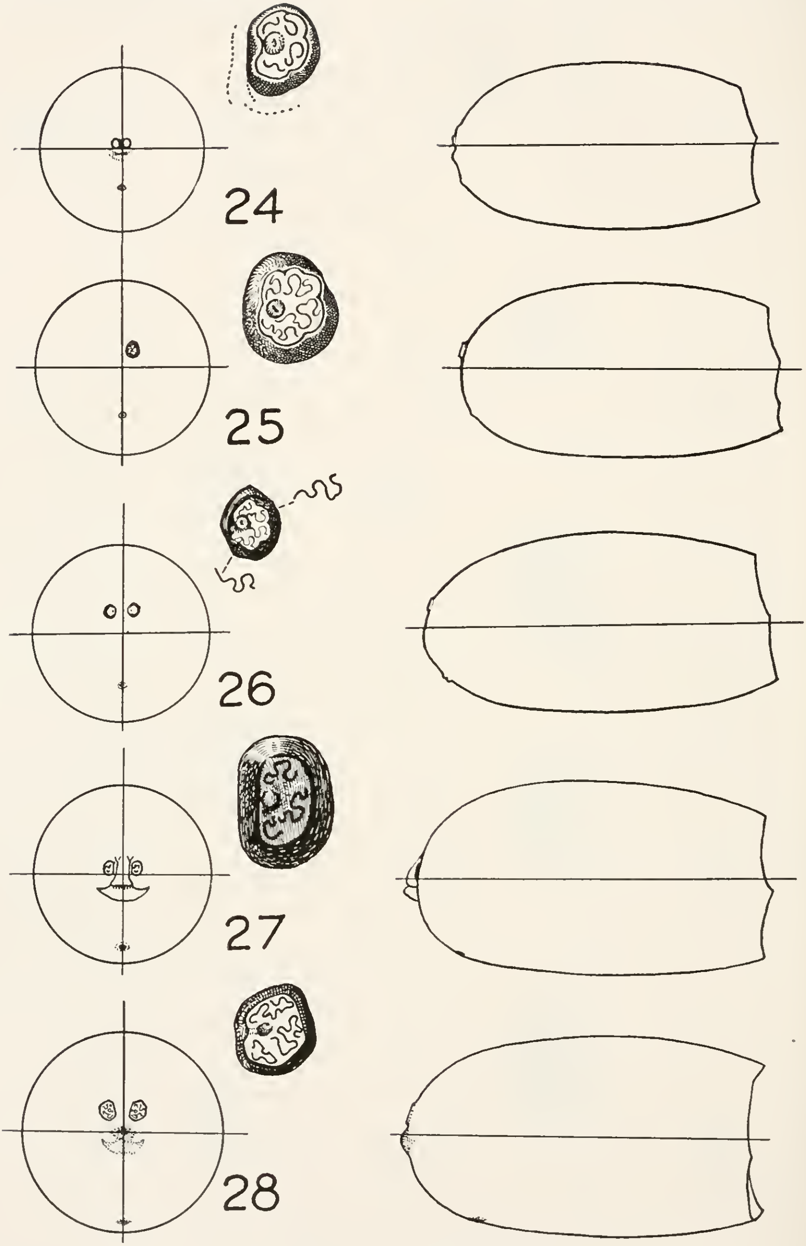

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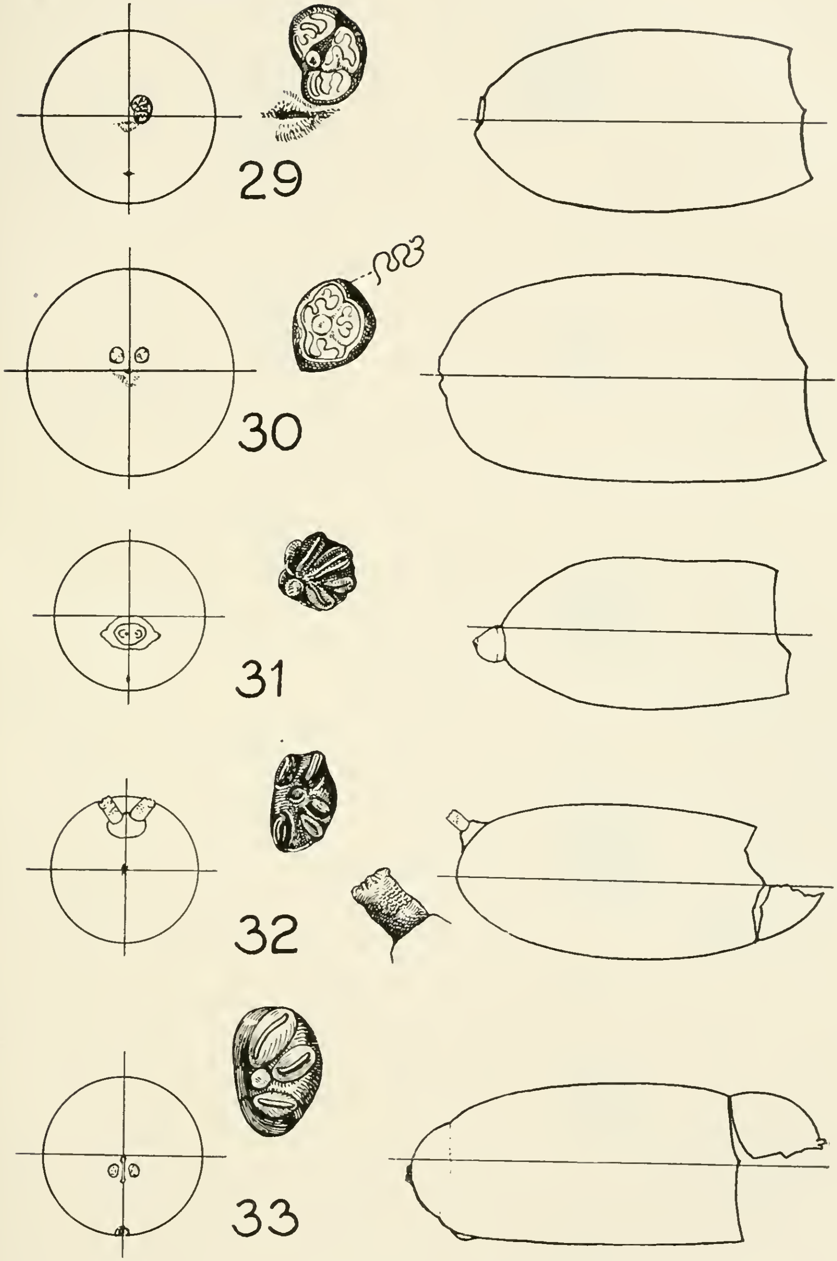

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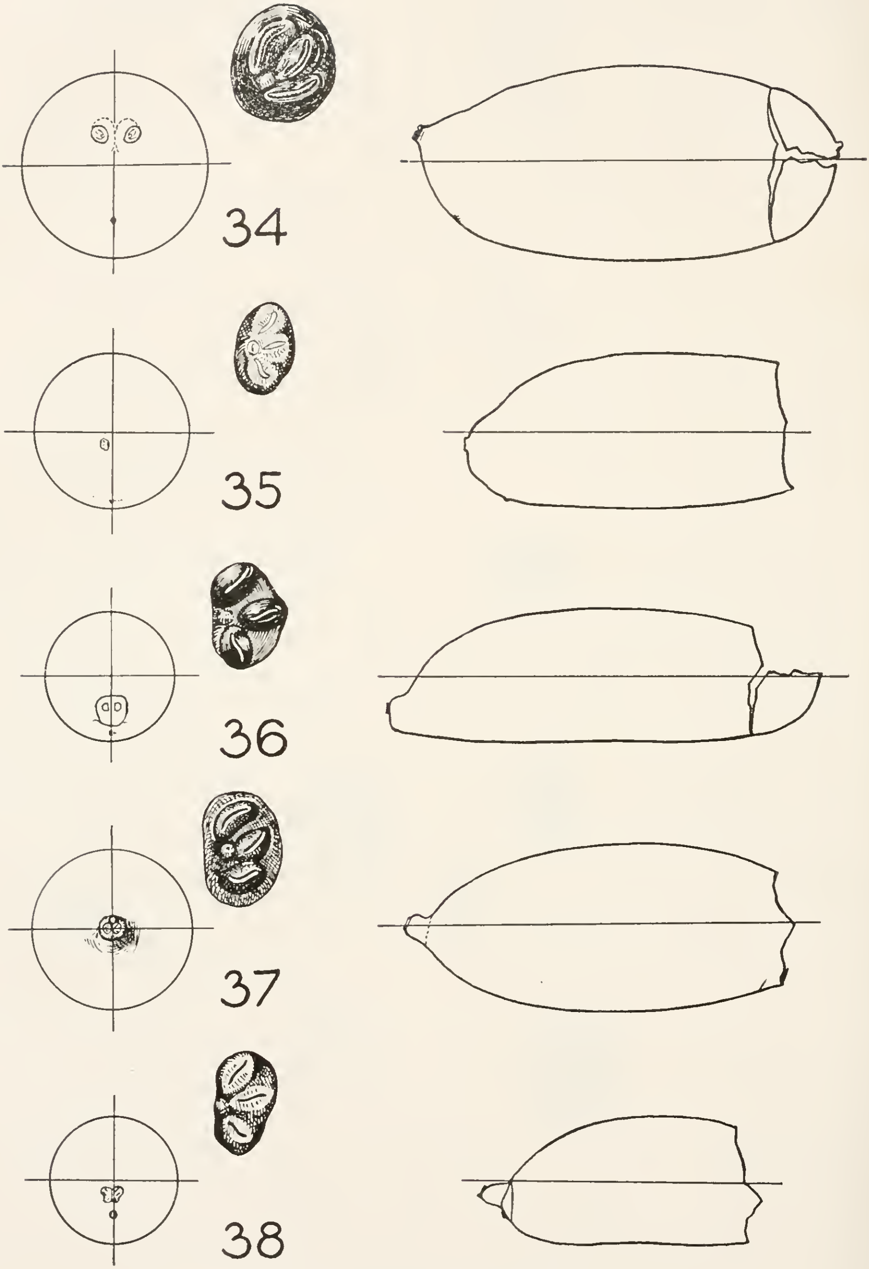

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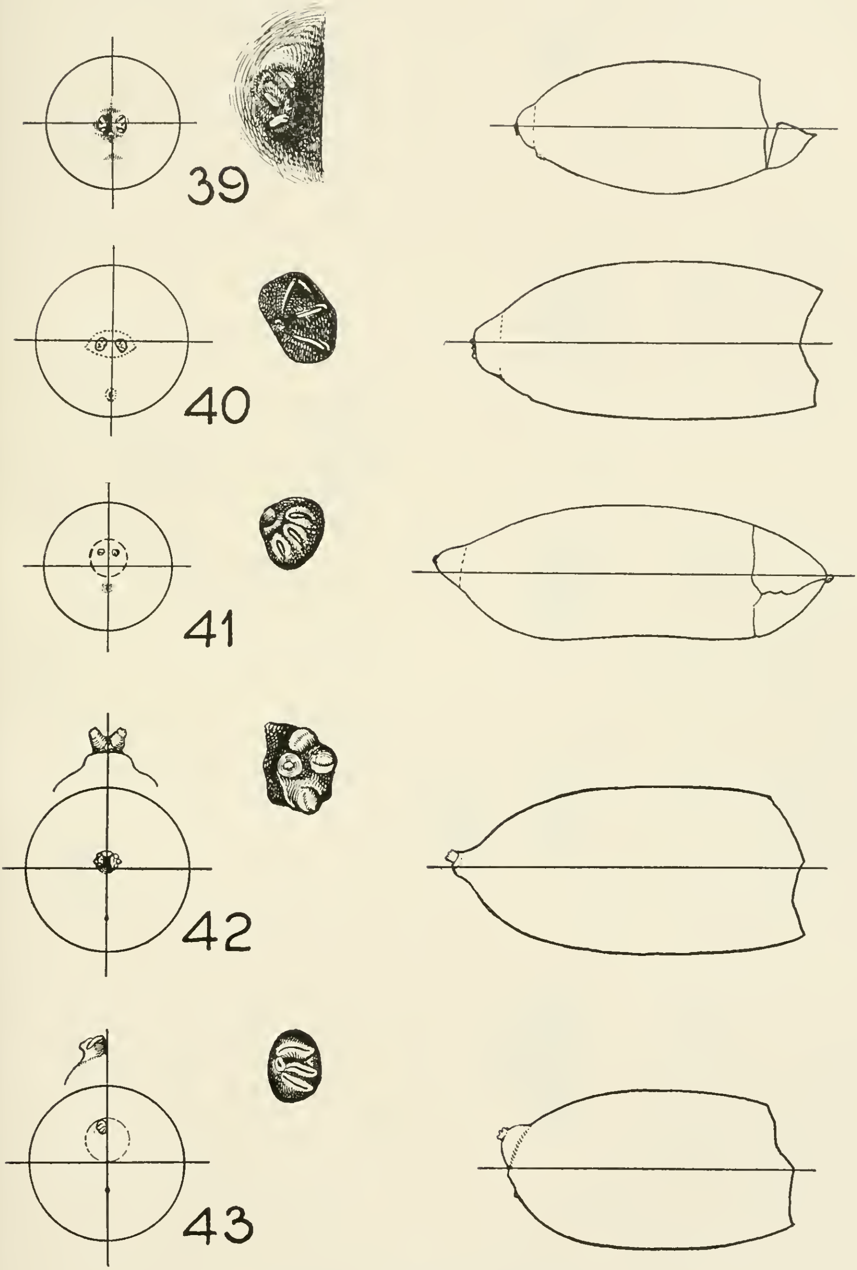

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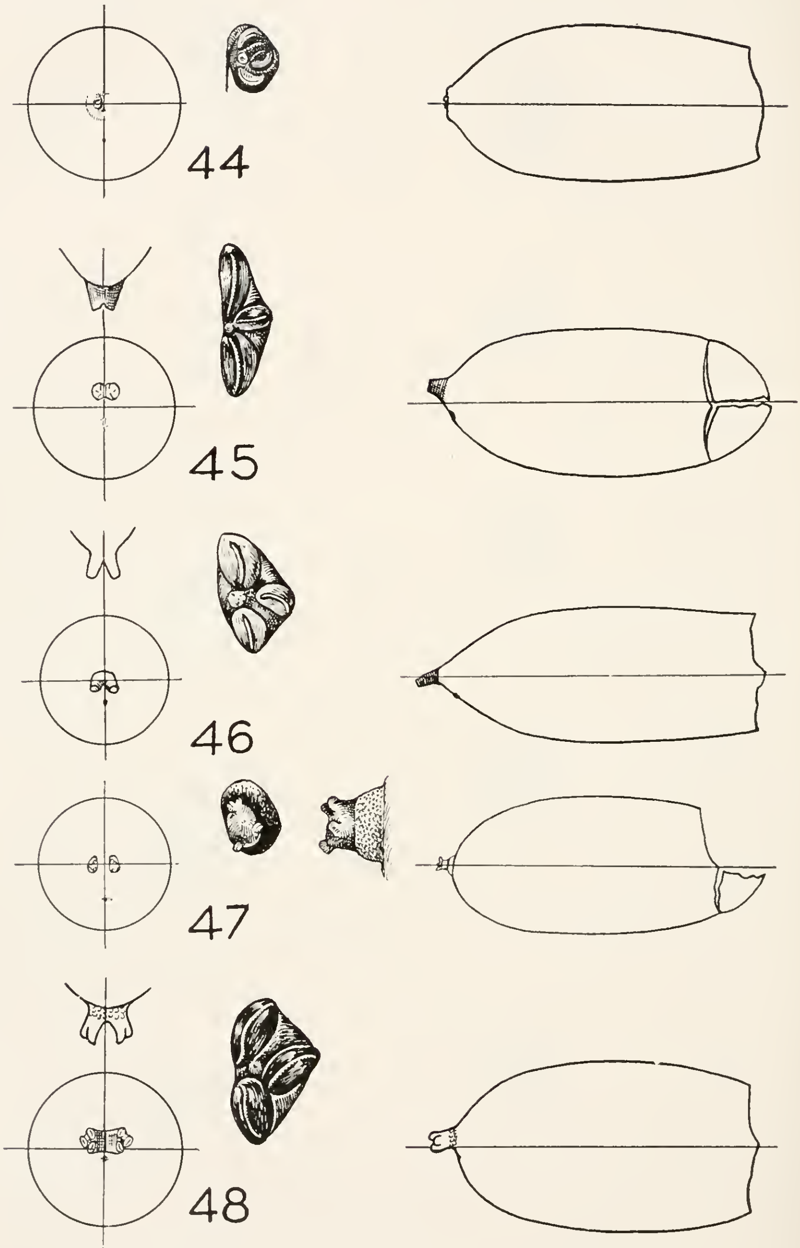

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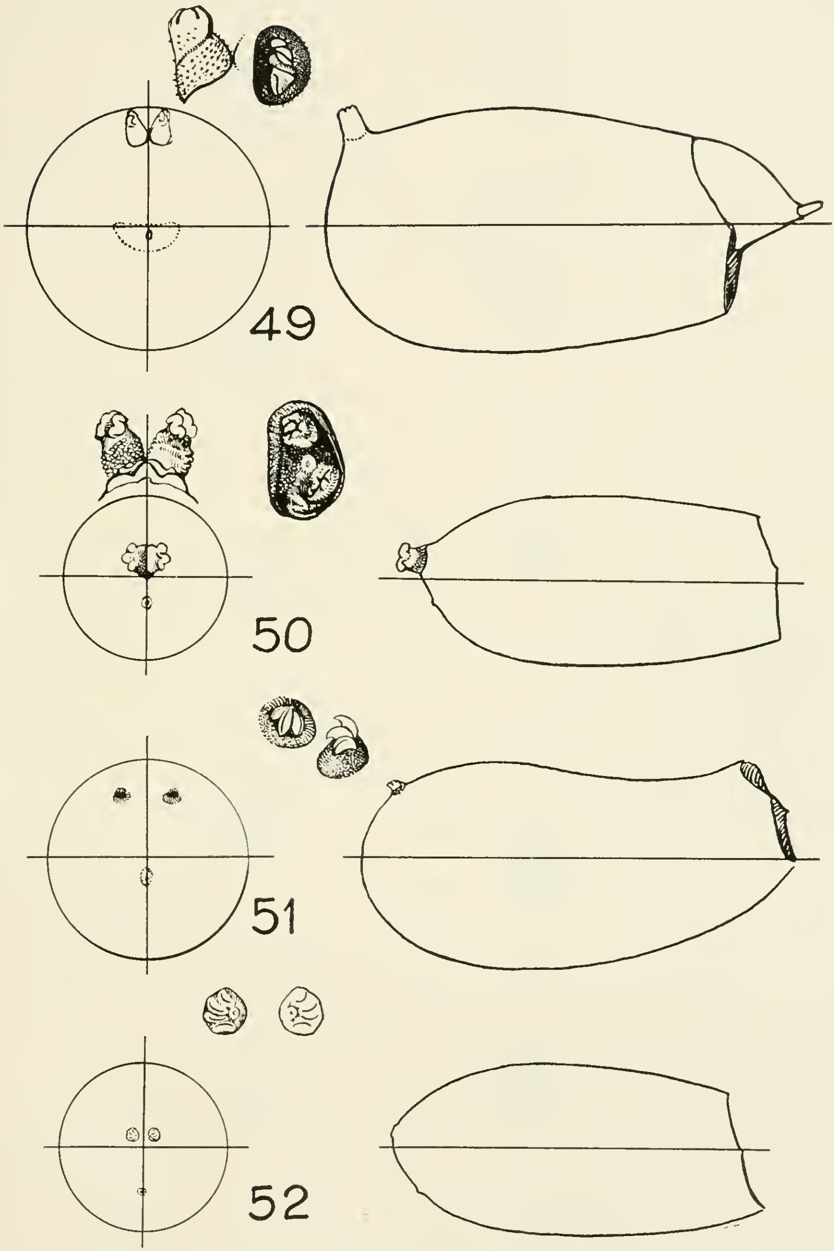

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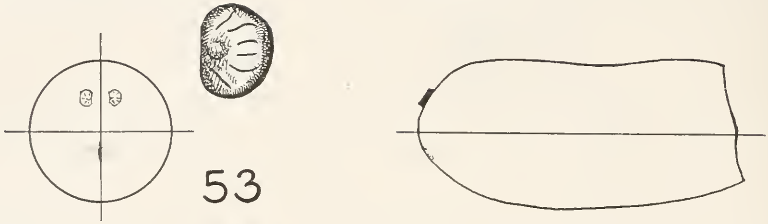

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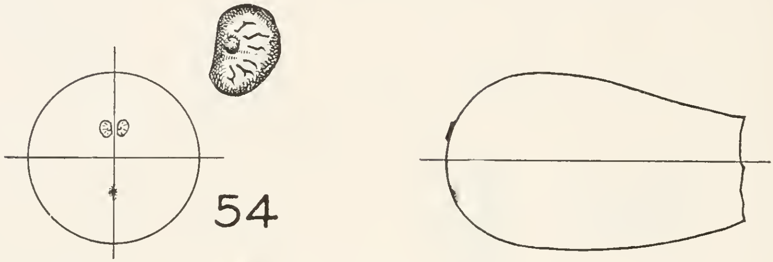

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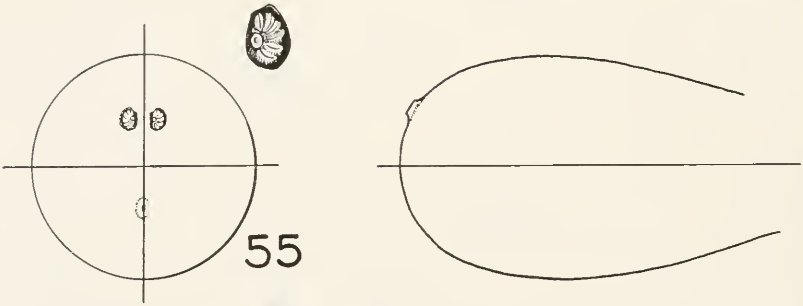

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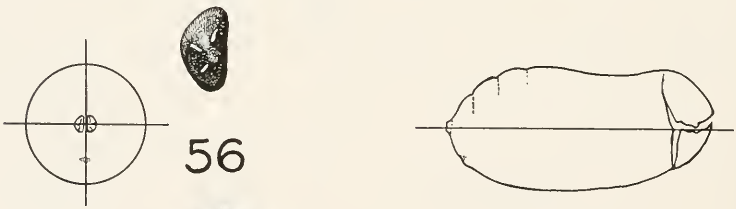

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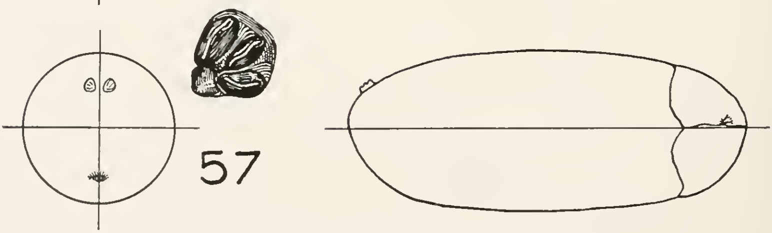

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PUPARIA OF MUSCOID FLIES.

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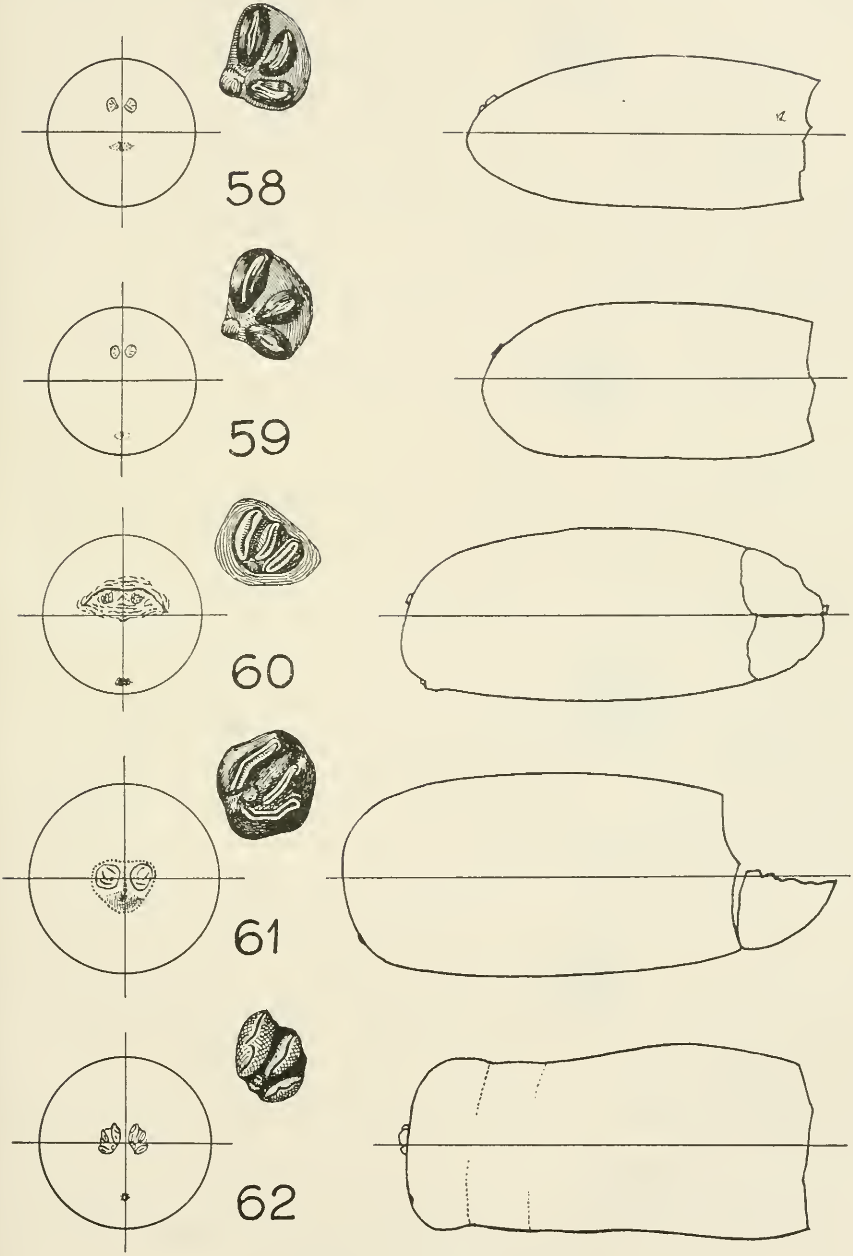

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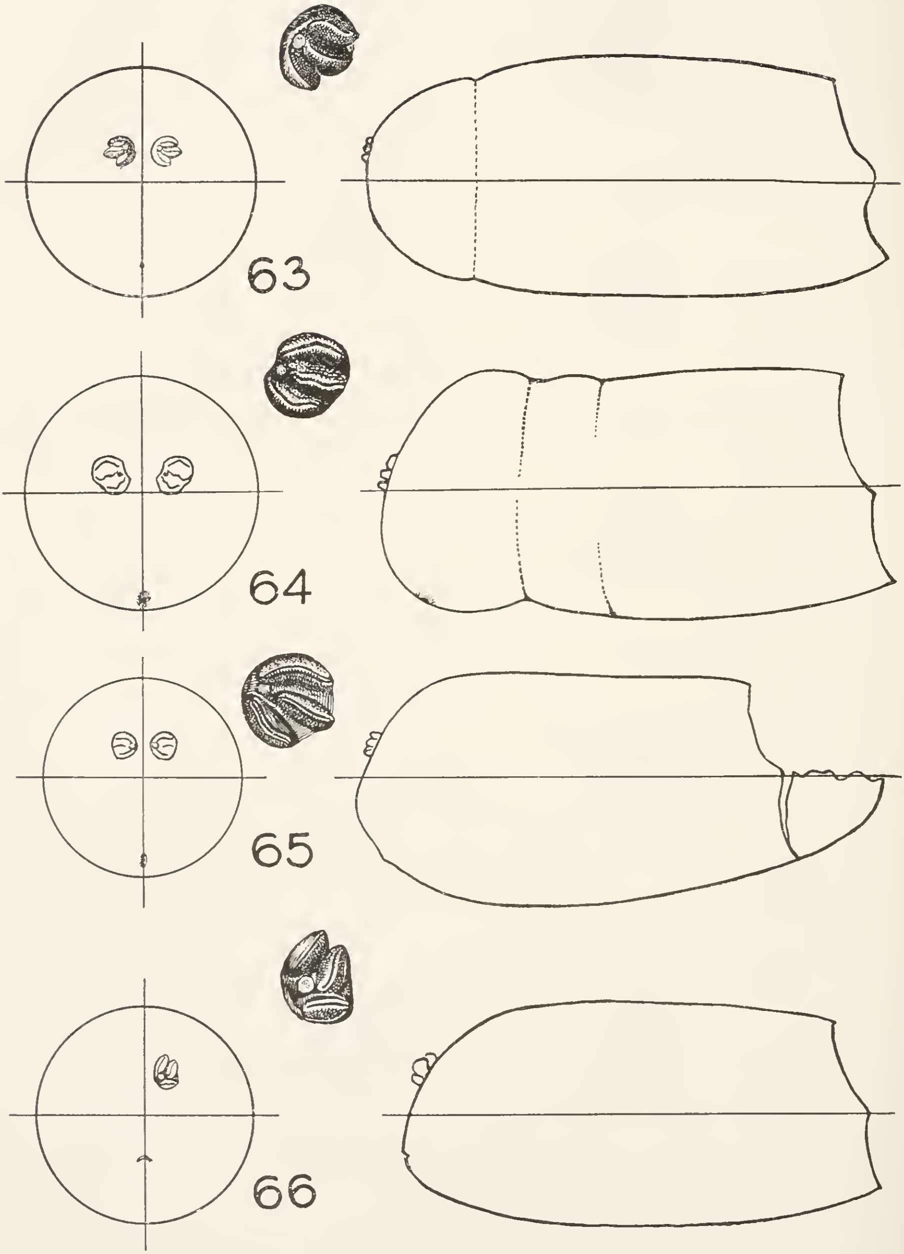

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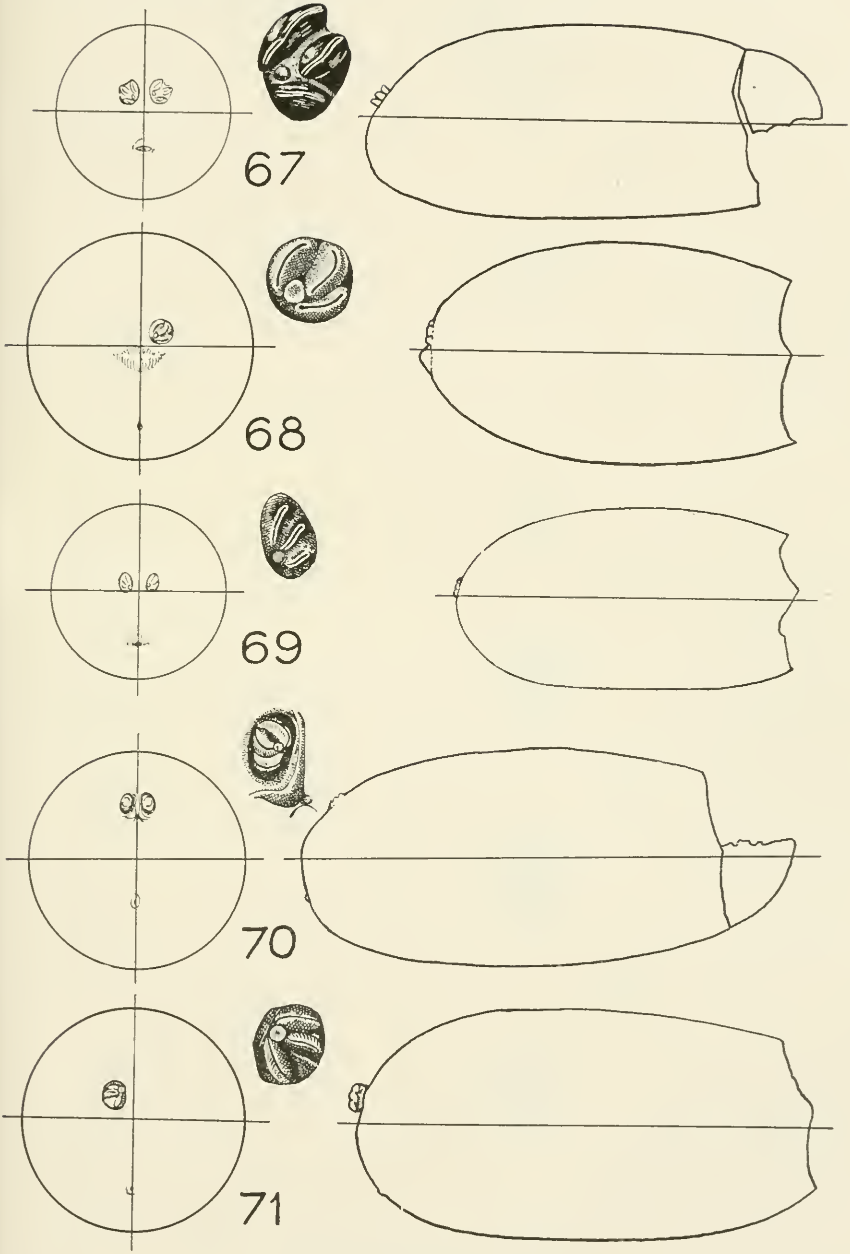

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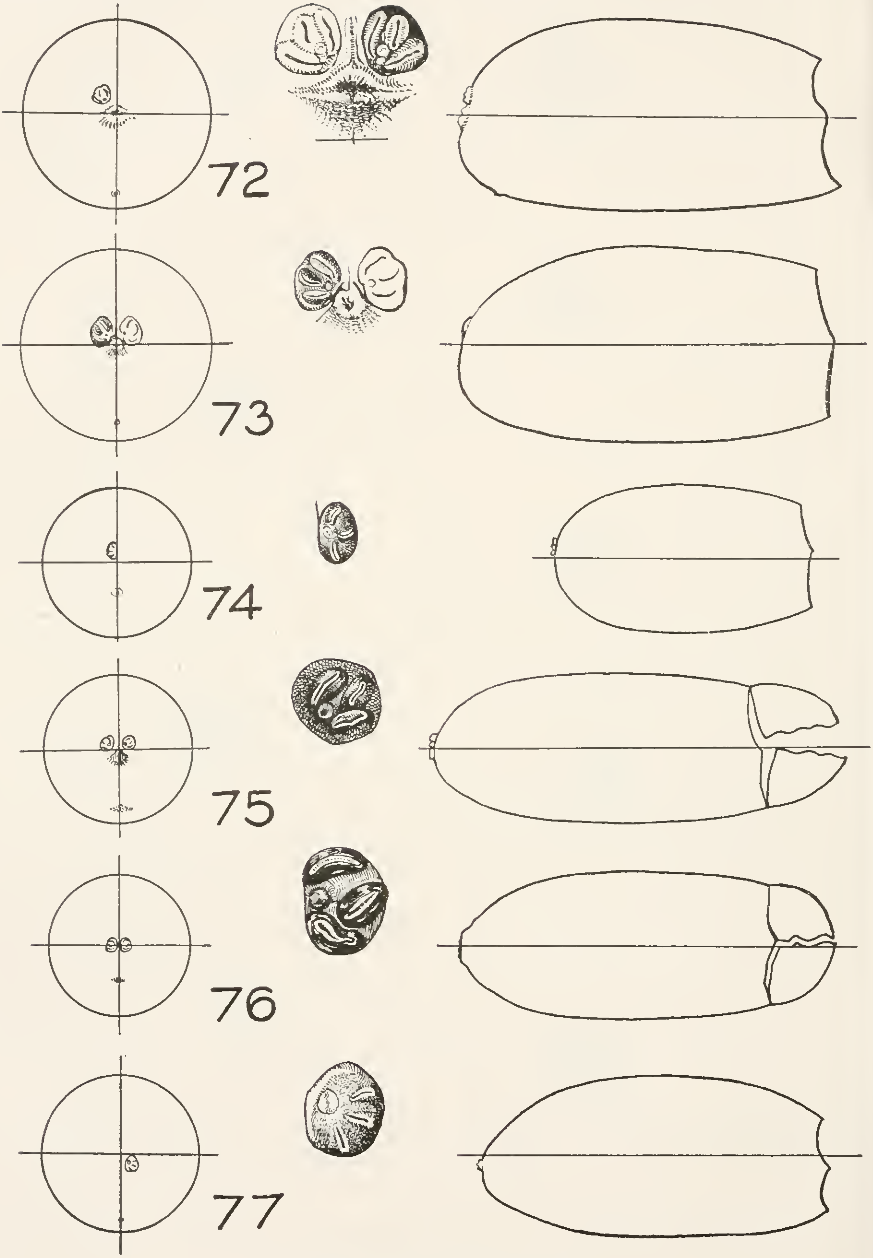

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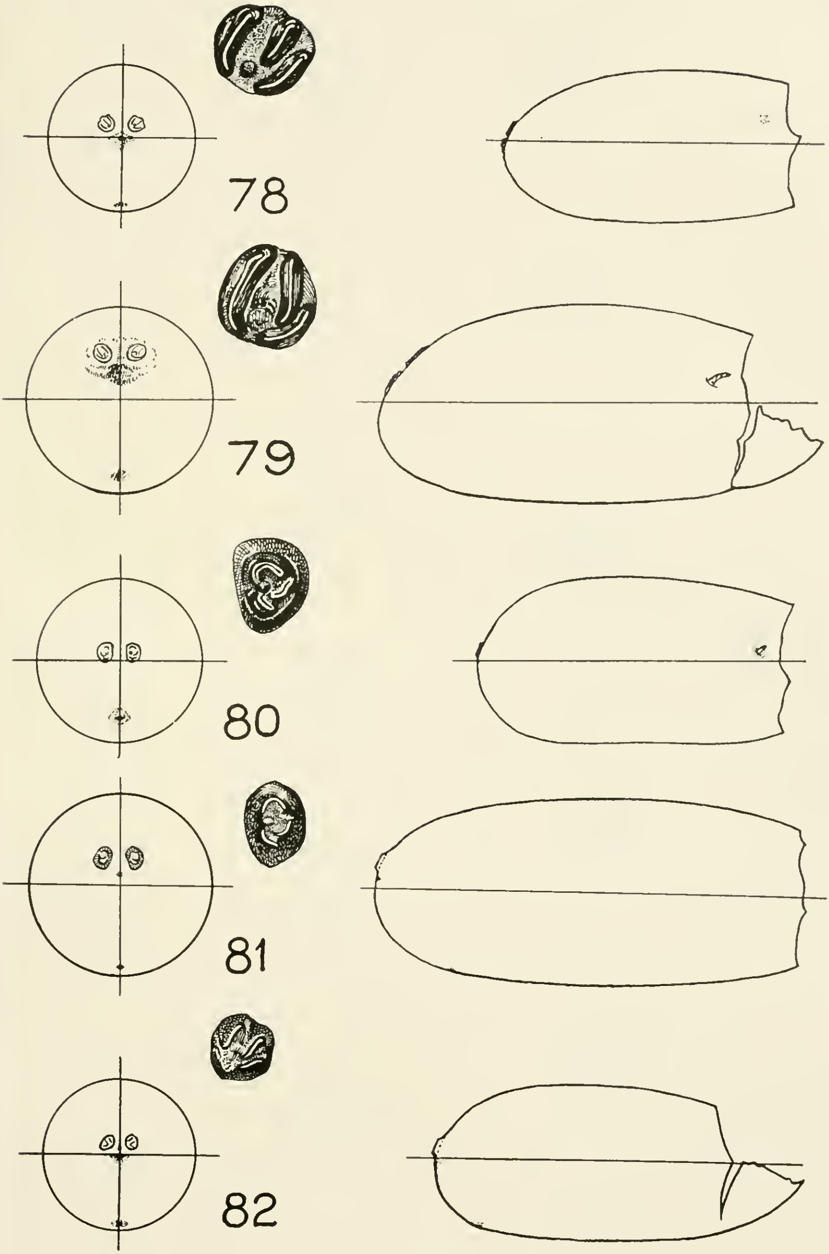

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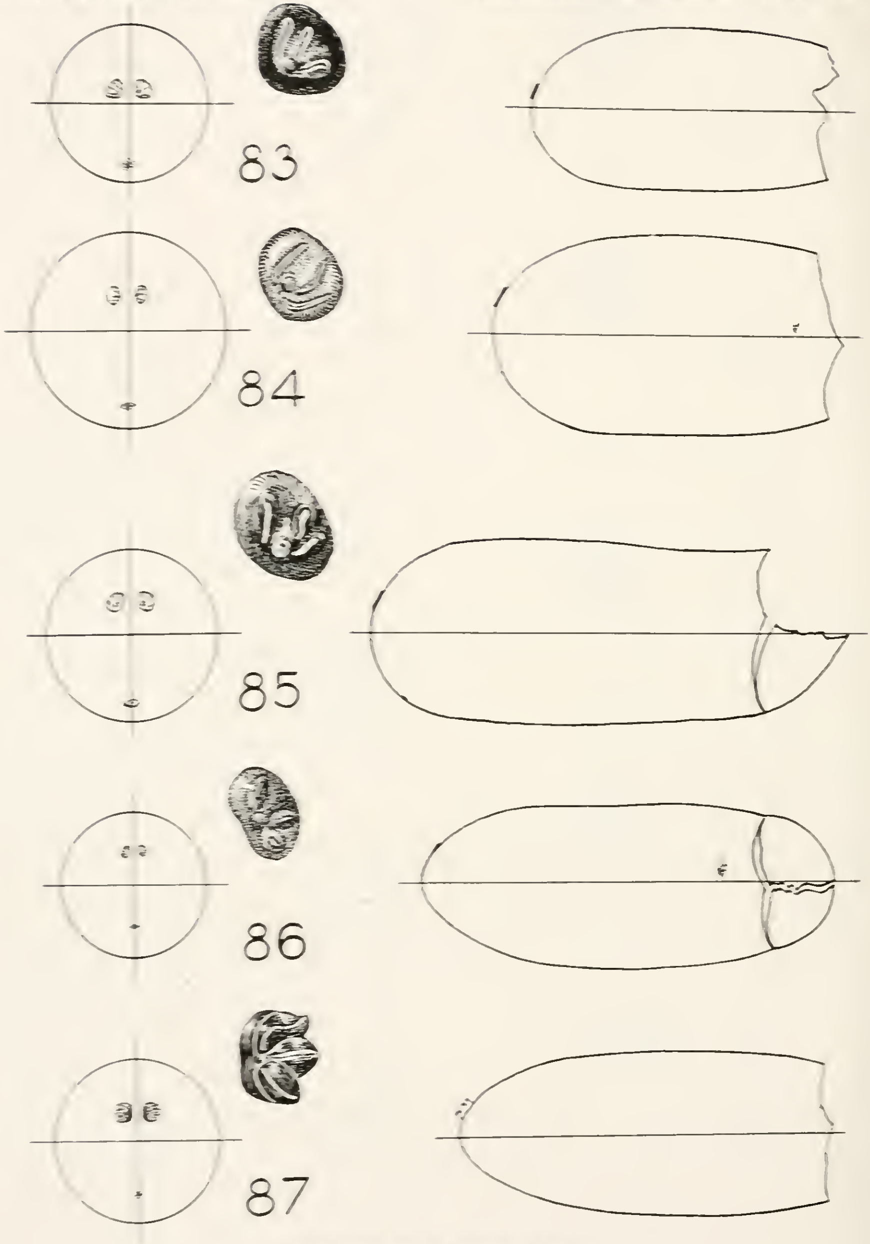

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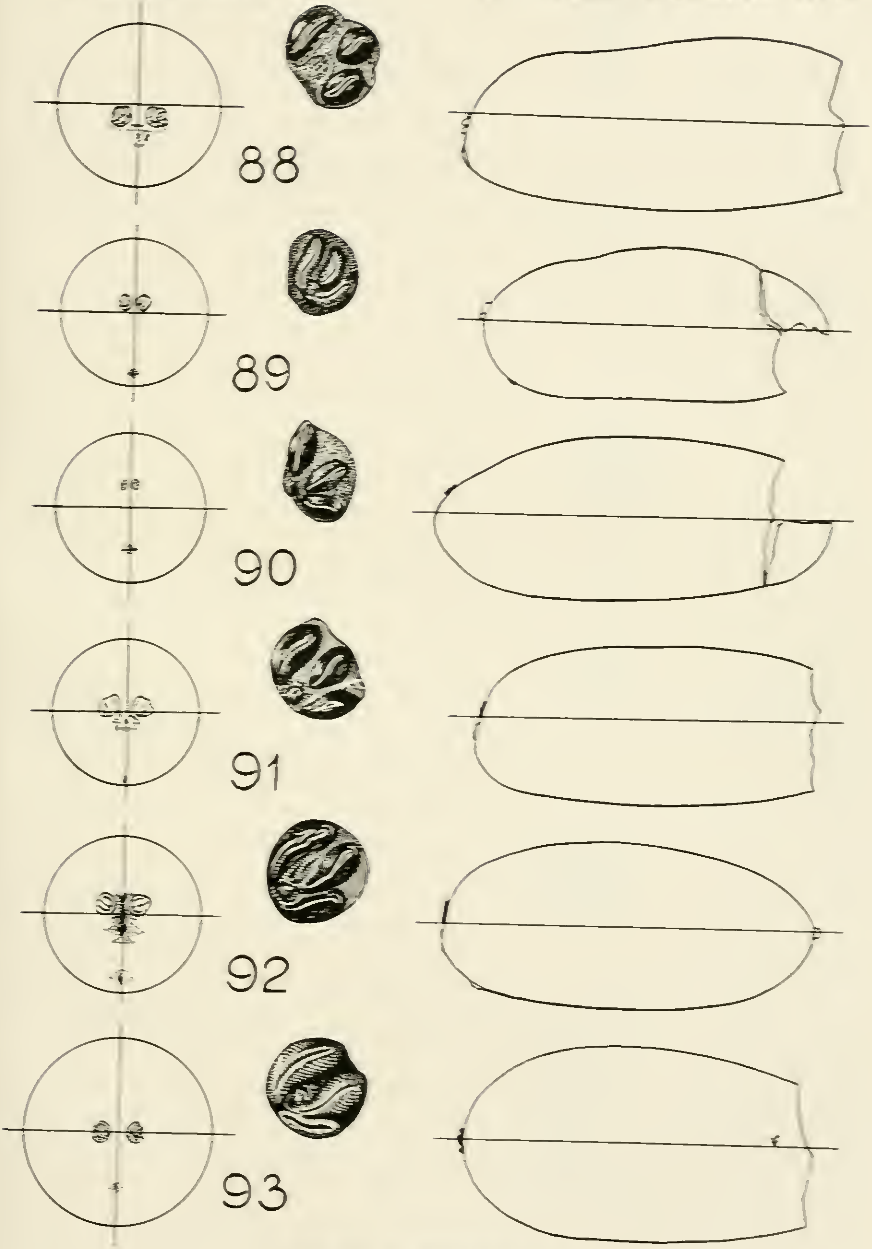

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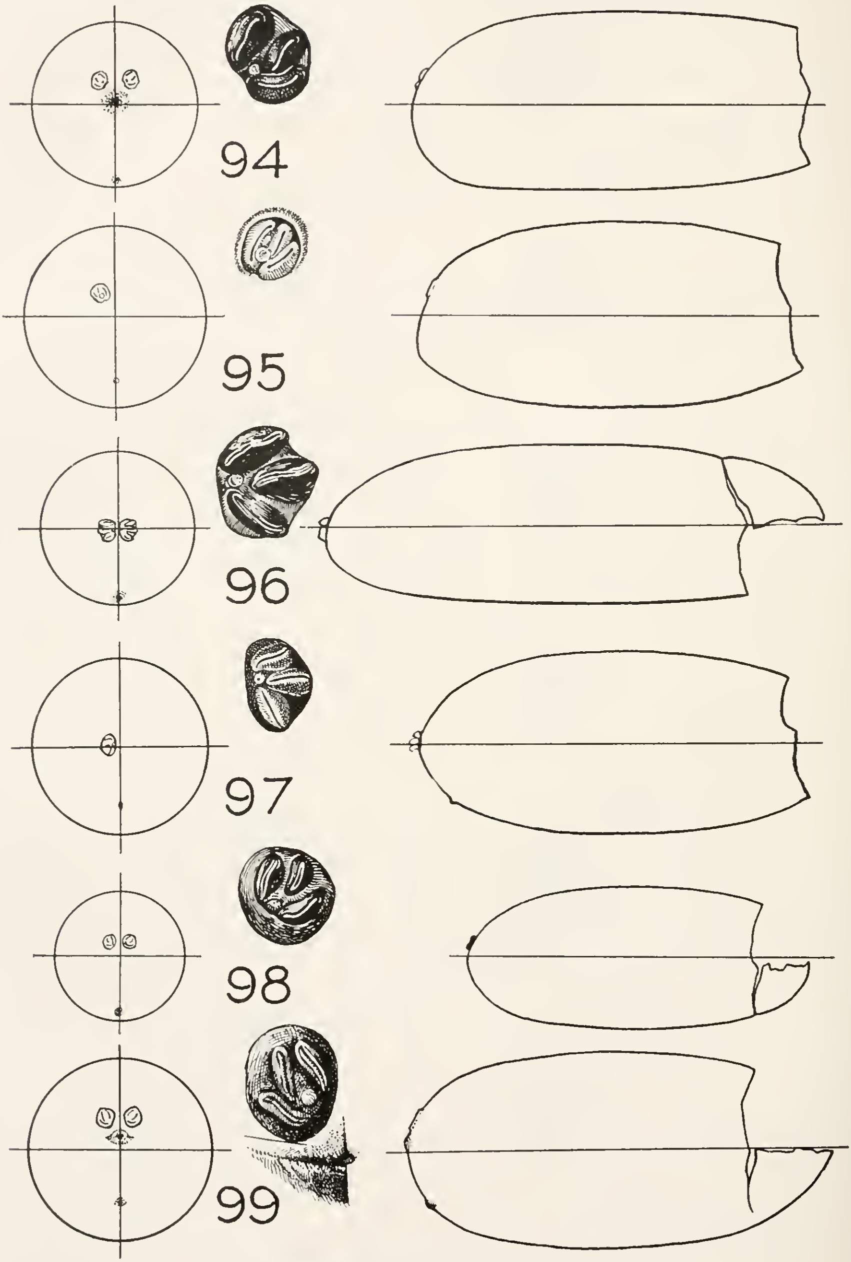

PUPARIA OF MUSCOID FLIES.

FOR EXPLANATION OF PLATE SEE PAGE 36.

INDEX.

This index includes all the generic and specific names included in this paper. Generic names are in bold face type, specific names in roman. When any genus contains more than one species the specific names are listed following the generic as well as occurring in their regular alphabetical place. When the same specific name is used in different genera the generic name is added in parentheses.

NOTES ON NEARCTIC BIBIONID FLIES.

By W. L. McAtee,

Of the United States Biological Survey.

INTRODUCTION.

Wishing to identify some Bibionidae and finding no keys available the writer decided to make some. The resulting keys and notes are based largely on the collections of the United States National Museum, and it is hoped that they will be useful to others desiring to study this neglected family. Among Nemocera in general the Bibionidae are distinguished by absence of transverse suture in mesonotum and of discal cell in wing, forking of the radial sector beyond the discal cross vein, and presence of three large ocelli on a well-developed ocellar prominence. Eliminating the flies properly separable as the family Scatopsidae, the Bibionidae may be separated from their nearer relatives with fair satisfaction. From all but the most primitive Mycetophilidae (*Paleoplatyura*, *Apemon*, etc.) they are distinguished by possession of two basal cells in the wing; most of them have short and compact (even if many-jointed) antennae, again in contrast to the majority of Mycetophilidae. The latter usually have all of the tibiae conspicuously spurred, while in the Bibionidae spurs of any magnitude are confined to the front tibiae. The Scatopsidae differ from the Bibionidae in much smaller average size, in possession of but one basal cell, and general reduction in venation. In these characters again they approach the Mycetophilidae, which differ, however, in the elongation of the coxae, and usually of the other leg joints and antennae.

In identifying various Bibionidae it is especially desirable, sometimes necessary, to have associated sexes of the species. By bearing this in mind collectors can greatly help the study of this family. Bibionidae exhibit what is apparently more than a fair share of injuries and malformations which may be connected with emergence from the soil. Distorted tarsal joints are not rare, and in the course of the present study the following more important abnormalities were observed: *Bibio femoratus* Wiedemann, a female from Plummers Island, Maryland, April 30, 1911 (W. L. McAtee), has the left front leg lacking a tarsus, the tibia being only about half the nor-

mal length and tapering off rather abruptly, ending in a short tubercle; *Bibio fraternus* Loew, a specimen collected at Castle Rock, Pennsylvania, May 3, 1908 (H. S. Harbeck), has the basal fourth of each hind tibia constricted, so as to form an extra joint in the leg, imperfect on one side, but apparently perfect on the other. In this connection it is worth recalling Dr. W. M. Wheeler's record[1] of an antenniform appendage branching from a fore coxa of *Dilophus tibialis* Loew.

The writer is indebted for loan of material used in the present study to Prof. J. M. Aldrich, curator of the Division of Insects, United States National Museum.

The location of types and other specimens is shown by names or initials in parentheses after citation of locality records. Type localities of described species are named in brackets following bibliographical citations.

KEY TO GENERA.

A. Third longitudinal vein furcate (Pleciinae).
- B. Fourth and fifth veins forked.
  - C. Distance between anterior cross vein and fork of fourth vein more than twice length of cross vein; antennae twelve-jointed ---------- **Hesperinus**
  - CC. Distance between anterior cross vein and fork of fourth vein much less than twice length of cross vein; antennae 8- to 9-jointed.
    - D. Fork of third vein very long, beginning near anterior cross vein; costal margin of wing sinuate ---------- **Crapitula** [2]
    - DD. Fork of third vein much shorter, its origin remote from anterior cross vein; costal margin of wing not sinuate ---------- **Plecia.**
- BB. One or both of these veins not forked.
  - E. Fifth vein not forked ---------- **Penthetria.**[3]
  - EE. Neither the fourth nor fifth veins forked ---------- **Eupeitenus.**[4]

AA. Third longitudinal vein not furcate (Bibioninae).
- F. Front tibia with two spurs at apex, the outer stronger.
  - G. Third and fourth longitudinal veins coalescent for a short distance. **Bibiodes.**
  - GG. Third and fourth veins not coalescent, joined by the anterior cross vein ---------- **Bibio.**
- FF. Front tibia with two or three series of spines; thoracic notum crossed by two pectinate ridges ---------- **Dilophus.**

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[1] Arch. f. Entw. Mech. d. Org., vol. 3, 1896, pp. 26,108, pl. 16.

[2] Gimmerthal. An Asiatic genus; characters used in key derived from Loew's figure, Berl. Ent. Zeit., 1858, pl. 1, fig. 12.

[3] Latreille. A European genus; characters used in key derived from Meigen's figure, Syst. Besch. Europ. zweifl. Ins., vol. 1, 1818, pl. 10, fig. 18. Loew (work cited, p. 105) states that the venation in the sexes is alike and that consequently Meigen's figure 17 of the male is incorrect.

[4] Macquart, not Serville, as the former writes; he adopted a cabinet name of Serville, but published the original description himself (Dipt. Exot., vol. 1, 1838, pp. 84–5). Genotype *Penthetria atra* (Macquart, Hist. Nat. des. Insectes, vol. 1, 1834, p. 175) described from Philadelphia, but no specimens have been seen by the present writer. Characters used in the key derived from Macquart's figure (work first cited, pl. 12, fig. 3). Van Der Wulp identifies *P. atra* from Wisconsin (Tijds. v. Ent., vol. 5, 1869, p. 80). For description (as a new genus) of the fly identified as *Eupeitenus* by Coquillett see Proc. Ent. Soc. Wash., vol. 23, 1921, p. 49.

Genus HESPERINUS Walker.

HESPERINUS BREVIFRONS Walker.

Hesperinus brevifrons WALKER (Francis), List of the Specimens of Dipterous Insects in the Collection of the British Museum,[5] pt. 1, 1848, p. 81 [St. Martin's Falls, Albany River, Hudson Bay].

More slender than the average Bibionid, antennae and legs elongate. Antennae twelve-jointed, second joint short, third about twice as long as fourth; general color of head and body black with grayish pruinose markings, the chief elements of which are a broad median and narrower lateral vittae on thorax, and a narrow median line on abdomen; head and thorax with short, abdomen, with longer pale hair; genital segment of male with a broad rounded cleft nearly half its length; anal plate rounded emarginate; legs copiously bristly-hairy, yellow brown, darker at end of joints especially on tarsi; halteres long, slender, stramineous; wings dusky hyaline, veins and stigma brown. Length of wings, 7 mm.

Specimens examined are from Currant Creek Valley, elevation 8,000 feet, Uinta National Forest, Utah, June 25, 1917, J. Silver (Biol. Survey). The species has been recorded also from New Hampshire, Rocky Mountains and Alaska.

This is one of the genera on the vague border line between the Mycetophilidae and Bibionidae; the long slender antennae and general appearance ally it to the former, but the lack of conspicuous spurs on posterior tibiae and presence of complete second basal cell in wing connect it perhaps more closely with the latter. Johannsen[6] ranges this genus with the Bibionidae, but *Hesperodes*, which Coquillett compared[7] with it, he assigns to the Mycetophilidae.

Genus PLECIA Wiedemann.

KEY TO SPECIES.

A. Both sexes with the face produced in a beak as long as remainder of head; top of thorax reddish yellow; pleura and coxae brown to black____bicolor.

AA. Species without beak.

B. Whole of thorax and coxae yellow________________________________confusa.

BB. Body and legs wholly black__________________________________heteroptera.

PLECIA BICOLOR Bellardi.

Plecia bicolor BELLARDI (Luigi), Saggio di Ditterologia Messicana, pt. 1, 1859, p. 16 [Cordova, Orizaba, Mexico].

Beak as long or longer than remainder of head, narrowed a little before apex where palpi are inserted; eyes large and contiguous in male, small and well separated in female. Top of thorax reddish

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[5] References are given in full the first time cited and abbreviated thereafter.

[6] The Fungus Gnats of North America, pt. 1, Bull. 172, Maine Agr. Exp. Sta., Dec., 1909, p. 222.

[7] Two New Genera of Diptera, Ent. News, vol. 11, No. 4, Apr., 1900, p. 429.

yellow, remainder of body and legs brown to black; hind femora but not the tibiae clavate, metatarsus about equal to next three joints; wings smoky brown. Length of wing, 5–8 mm.

A male and female labeled Tex. (U.S.N.M) and numerous specimens of both sexes from Orange, Texas, September 4, 1915, and Vinton Louisiana, September 5, 18, 1916, E. G. Holt, agree with others from Mexico and Central America.

Identification of this species as *P. bicolor* Bellardi is by no means certain. I have seen another species from Guatemala which fits the original description just as well. It has the hind metatarsus distinctly longer than the succeeding three joints of the tarsus, while the species here treated has these parts of about equal length. However, since specimens of the latter from Mexico are at hand and the known range is greater, indicating it may be the frequently recorded *bicolor*, that name is provisionally applied to it. Williston[8] places *bicolor*, as a synonym of *collaris*, upon what grounds he does not say and I am unable to infer. The probabilities are against their being identical; we can be sure that they are at least varietally distinct.

PLECIA CONFUSA Loew.

Plecia confusa Loew (Hermann), Ueber einige neue Fliegengattungen, Berliner Entomologische Zeitschrift, vol. 2, 1858, p. 109. [A new name for *Plecia ruficollis* Fabricius (J. C.), Systema Antiliatorum, 1805, p. 53, Middle America, as distinguished from *Plecia ruficollis* Fabricius, Species Insectorum, vol. 2, 1781, p. 410, Cape of Good Hope.]

Head without beak, eyes as in last species; whole thorax and coxae dull to bright orange or reddish yellow; remainder of body brown to black; wings smoky brown; hind femora but not the tibiae clavate; hind metatarsus about as long as succeeding three joints. Length of wing, 6–8 mm.

Specimens collected in Florida by Maynard and at Waco, Texas, by Belfrage are in the national collection. Loew's proposal of a new name for the American species resembling *Plecia ruficollis* Fabricius has been generally overlooked, but had Loew not taken such action it would have been done by some later student of the group, for there is very little probability that species from the Cape of Good Hope and from Middle America are identical. Further material and research may even show that Loew's name is too inclusive.

PLECIA HETEROPTERA Say.

B. [*ibio*] *heteropterus* Say (Thomas), Descriptions of Dipterous Insects of the United States, Journ. Acad. Nat. Sci. Philadelphia, vol. 3, 1823, p. 78; Compl. Writings, vol. 2, 1859, p. 69 [Maryland].

Head without beak; eyes contiguous above in male, small and widely separated in female, ocellar tubercle prominent. A wholly

[8] Biol. Centr. Amer., vol. 1, Suppl., p. 222, 1900.

black species (females sometimes brown), body opaque, occiput, and abdomen with rather long black hairs; long, slender, hind femora and tibiae clavate; hind metatarsus swollen (in male), about as long as next three joints together. Length of wing, 7–9 mm.

The known range of this species extends from Quebec and South Dakota to Georgia, Louisiana, and Colorado.

UNIDENTIFIED SPECIES.

PLECIA BIMACULATA Walker.

Plecia bimaculata WALKER (Francis), Insecta Saundersiana, vol. 1, Diptera, 1856, p. 422 [United States]. May be a *Dilophus*.

PLECIA LONGIPES Loew.

Plecia longipes LOEW (H.), Neue Fliegengattungen, Berl. Ent. Zeitsch., vol. 2, 1858, pp. 109–110 [New Orleans]. May be the same as *P. heteroptera* Say.

Genus BIBIODES Coquillett.

KEY TO SPECIES.

A. Thickened portion of costal margin extending about halfway from stigma to apex of wing; femora conspicuously swollen, antennae shorter___femorata.

AA. Thickened portion of costal margin extending much more than halfway from stigma to apex of wing; legs less robust; antennae longer.

B. Halteres yellow; tarsal joints slender________________________halteralis.

BB. Halteres dark, at least apically; tarsal joints somewhat swollen__aestiva.

BIBIODES AESTIVA Melander.

Bibiodes aestiva MELANDER (A. L.), The Dipterous Genus Bibiodes. Bull. Amer. Mus. Nat. Hist., vol. 21, art. 27, Oct. 1, 1912, pp. 338–340 [Washington, Idaho, Montana, Wyoming].

Male.—Head and body shining black, with sparse, rather long, pale hairs; coxae and femora of same color and vestiture; anterior tibiae piceous, spurs rufous; anterior tarsi usually black, but tibiae and tarsi of posterior legs more or less yellowish or rufous, the joints darker apically, sometimes appearing banded; knobs of halteres dark, stalks pale; wings hyaline, stigma and veins near costa dark brown, remainder merely yellowish. Length of wing, 3.5–4 mm.

Specimens examined are four male paratypes from Lewiston and Craig's Mountain, Idaho (Aldrich).

BIBIODES FEMORATA Melander.

Bibiodes femorata MELANDER (A. L.), Bull. Amer. Mus. Nat. Hist., vol. 21, p. 340 [Austin, Texas].

Male.—Brownish black, shining, with plentiful, rather long, pale hair; spurs of front tibiae rufous; halteres pale fuscous; wings hyaline, stigma and veins near costa brown, remainder merely yellowish fumose. Length of wing, 3.5 mm.

Specimens examined are two male paratypes, Austin, Texas, December 13, 1899, A. L. Melander (Aldrich). On comparison with original description it would appear that these specimens have faded; that description alluding to jet-black general color and black halteres.

I have not described the genitalia of the species of this genus, as it is not necessary at present to base the classification upon them.

BIBIODES HALTERALIS Coquillett.

Bibiodes halteralis Coquillett (D. W.), New North American Diptera, Proc. Ent. Soc. Wash., vol. 6, No. 3, July, 1904, p. 171 [California].

Male.—Black, shining, legs dark reddish brown; halteres yellow; head with short, body and legs with rather long yellowish white hairs; spurs of front tibiae rufous, the outer long and stout, the inner a mere pointed tubercle; wings nearly hyaline; the anterior veins and stigma brown, the posterior nearly colorless. Length of wing, 3.5 mm.

Specimens examined are from San Mateo County, California, C. F. Baker (type); Los Angeles, California, Coquillett (U.S.N.M.); Claremont, California, Baker (Aldrich).

Genus BIBIO Geoffroy.

A considerable number of the older names applied to American species of this genus remain unidentified. This is chiefly due to the fact that characters used in later diagnoses are not mentioned in earlier ones, and that elucidation of the obscure points has not been possible on account of lack of types or of opportunity of examining those in existence.

The male genitalia of *Bibio* undissected have not been found available for taxonomic use. They are not heavily chitinized, hence are not all constant in appearance in dried specimens of the same species; the superior plate is decidedly emarginate in all species examined, but the width of the emargination varies greatly, being strictly correlated with the degree to which the forceps are spread. Dissection of excised genitalia has not been attempted.

KEY TO THE SPECIES: MALES.

A. Inner spur of front tibia long, sometimes nearly as long as outer.
  B. Legs almost entirely black ____ **criorhinus.**
  BB. Legs with at least one joint yellow to rufous.
    C. Only the femora rufous ____ **femoratus.**
    CC. More of legs yellow to rufous.
      D. Smaller species (wing, 4.5–6.5 mm.); body with rather short pale hair.
        E. Hind metatarsus distinctly shorter than succeeding three joints together ____ **abbreviatus.**
        EE. Hind metatarsus about as long as succeeding three joints together. **fraternus.**
      DD. Larger species (wing, 7.5–9.5 mm.); body with copious long gray to black hair ____ **variabilis.**

AA. Inner spur of front tibia much shorter than outer.
F. Hind metatarsus distinctly enlarged, almost as thick as end of femur.
G. Legs brown to black, not distinctly bicolored.
H. Thorax and legs pale-haired---------------------------------longipes.
HH. Thorax and legs dark-haired--------------------------------slossonae.
GG. Legs distinctly bicolored.
I. Tibiae, hind femora, and basal tarsal joints pale, dark-tipped. inaequalis.
II. All femora and succeeding joints yellow, dark-tipped-----fumipennis.
FF. Hind metatarsus not distinctly enlarged, considerably less in diameter than end of femur.
J. Legs almost entirely dark.
K. Smaller species (wing, 4–5 mm.); first joint of hind tarsus but little longer than second--tenuipes.
KK. Larger species (wing, 5–9.5 mm.); first joint of hind tarsus twice as long as second--albipennis.
JJ. Legs distinctly bicolored.
L. Only the femora (and front tibial spurs) yellow to rufous------holtii.
LL. More of legs yellow to rufous.
M. Tibiae and tarsal joints rufous, dark-tipped, femora brown to black --vestitus.
MM. Femora and succeeding joints yellow to rufous, dark-tipped.
N. Body usually pale-haired, leg joints pale, with dark tips.
O. Wings hyaline to yellowish fumose; front tibiae narrower in proportion to length-----------------------------------xanthopus.
OO. Wings usually dusky hyaline; front tibiae broader in proportion to length--nervosus.
NN. Body dark-haired; leg joints often considerably dark-clouded. tristis.

KEY TO THE SPECIES: FEMALES.

A. Inner spur of front tibia long, sometimes nearly as long as outer.
B. Only the femora rufous; wings blackish----------------------femoratus.
BB. More of legs yellow to rufous.
C. Wings yellow brown, darker costally.
D. Smaller species (wing, 4-5–6.5 mm.).
E. Hind metatarsus distinctly shorter than succeeding three joints together; thorax dark------------------------------------abbreviatus.
EE. Hind metatarsus about as long as succeeding three joints together; thorax chiefly yellow to rufous-------------------fraternus.
DD. Larger species (wing, 7.5–9.5 mm.)------------------------variabilis.
CC. Wings smoky, blackish costally---------------------------------basalis.
AA. Inner spur of front tibia much shorter than outer.
F. Body and legs brown to black, with pale hair.
G. Smaller species (wing, 4–5 mm.)---------------------------------tenuipes.
GG. Larger species (wing, 5.5–9.5 mm.)-------------------------albipennis.
FF. Body or legs in part yellow to rufous.
H. Abdomen black.
I. Top of thorax chiefly or entirely black.
J. Smaller species (wing, 5–6 mm.)---------------------------slossonae.
JJ. Larger species (wing, 7.5–9 mm.).
K. Entire anterior margin of mesonotum pale------------humeralis.
KK. Humeral ridge only pale.

L. Wings yellowish fumose; front tibiae narrower in proportion to length ---------- **xanthopus.**
LL. Wings dusky hyaline, front tibiae broader in proportion to length ---------- **nervosus.**
II. Top of thorax yellow to rufous.
M. Top of thorax only rufous; legs black ---------- **rufithorax.**
MM. Whole thorax and legs pale, joints of latter dark-tipped -- **longipes.**
HH. Abdomen, as well as thorax and legs, testaceous, with only minor dark markings; head black ---------- **inaequalis.**

BIBIO ABBREVIATUS Loew.

Bibio abbreviatus LOEW (H.), Diptera Americae septentrionalis indigena, Centuria, 5, No. 9, 1864, Compl. Work, p. 217 [District of Columbia].

Male.—Head, body, and coxae black, the head with dark, the other parts with pale hair; femora and succeeding joints of legs yellow to rufous, dark-tipped; the front tibiæ almost wholly dark; spurs pale, subequal; wings chiefly hyaline, the anterior veins and stigma dark.

Female.—The female differs in having shorter hair of head pale, the coxae yellow to rufous and wings fumose.

The distinguishing character of the species is the short hind metatarsus, which in both sexes is distinctly shorter than the succeeding three joints of tarsus combined; the hind tibiae of males are somewhat enlarged.

Length of wing, 4–6 mm.

Van Der Wulp has repeated the combination *Bibio abbreviatus* in describing[9] a new species from Argentina.

Specimens examined were collected in Maryland, near the District of Columbia, and in Pennsylvania, Indiana, Michigan, Iowa, and South Dakota (all from the latter State being very small).

BIBIO ALBIPENNIS Say.

B. [*ibio*] *albipennis* SAY (Thomas), Desc. Dipt. U. S., Journ. Acad. Nat. Sci. Phila., vol. 3, 1823, p. 78; Compl. Writings, vol. 2, 1859, p. 69 [Pennsylvania].

KEY TO SUBSPECIES OF ALBIPENNIS.

A. Pile usually longer and more abundant, especially on males; western. **B. albipennis hirtus.**
AA. Pile shorter and less abundant; eastern ---------- **B. albipennis albipennis.**

BIBIO ALBIPENNIS ALBIPENNIS Say.

Bibliographical reference same as for species.

Male.—Head, body, and legs black, humeral ridge more or less marked with yellowish, legs brownish black distally, the tarsal joints narrowly pale basally; eyes with copious long, dark hair, remainder of body, coxae and femora with the same, pale yellowish to gray, tibiae with shorter dark hair; spurs of front tibiae very unequal.

[9] Tijds. v. Ent., vol. 24 (1880–81), 1881, p. 145.

often rufous-tipped, hind legs moderately elongate, the femora and tibiae clavate, the first tarsal joint more than twice as long as second; wings whitish hyaline, stigma and all veins dark, the latter pale toward base of wing.

Female.—The female frequently has the body color reddish brown to brownish black and differs otherwise by having shorter, all pale hair on head and body (vestiture of legs does not differ); hind tibiae not clavate; wings somewhat duskier.

Length of wing, 5–9.5 mm.

BIBIO ALBIPENNIS HIRTUS Loew.

Bibio hirtus Loew (H.), Dipt. Amer. Sept. indig., Cent. 5, No. 2, 1864, Compl. Work, p. 213 [California].

Similar to *albipennis* in every way, the only distinction being the more copious and longer hair, especially prominent in the case of males.

Individual eastern specimens may be practically as hairy as even Pacific coast flies, and specimens approaching *hirtus* seem to prevail in intermediate localities as Colorado and New Mexico.

The range of the western moiety of the species (*hirtus*) includes, on the basis of specimens examined, Idaho and the Pacific States from Orcas, Washington, to Pasadena, California, and the eastern subspecies (*albipennis*) from the Dakotas and Quebec south to North Carolina and Oklahoma.

BIBIO BASALIS Loew.

Bibio basalis Loew (H), Dipt. Amer. sept. indig., Cent. 5, No. 11, 1864 Compl. Work, p. 217 [New Hampshire].

Female.—Head and body black with short pale reddish hairs, coxae rufous the posterior ones obscured by darker, femora rufous, dark-tipped, front tibiae shining black with rufous subequal apical spurs, other tibiae rufous, tipped and more or less overlaid by black; tarsi chiefly dark, each joint pale basally; wings and veins dusky fumose darker costally. Length of wing, 5.5 mm.

A female collected at Manning, South Carolina, March 28–29, 1919, by E. R. Kalmbach answers to the description of *B. basalis*, except in size, which is notoriously variable in the genus.

BIBIO CRIORHINUS Bellardi.

Bibio criorhinus Bellardi (L.), Ditterologia Messicana, pt. 1, 1859, p. 17 [Mexico].

Black except the subequal spurs of front tibiae, and the hind tibiae and tarsi which are rufescent, and narrow bases of front tarsal joints which are yellowish; head, body, and coxae clothed with long dark hairs; those of the rather elongate legs shorter. Length of wing, 7 mm.

A male collected in the Graham Mountains, Arizona, June, 1914, E. G. Holt, is identified as this species; the size is rather larger than the type according to Bellardi's measurements, but size is very variable in *Bibio;* in other characters the specimen agrees well with the original description.

BIBIO FEMORATUS Wiedemann.

Bib[io] femorata WIEDEMANN (C. R. W.), Auszereuropaische zweiflügelige Insekten, vol. 1, 1828, p. 79 [North America].

Bibio fuscipennis MACQUART (J.), Dipteres nouveau ou peu connus, vol. 1, pt. 1, 1838, p. 87 [North America].

Male.—Head, body, and coxae black; legs black, the femora except their extremities, the anterior tibial spurs, bases of tarsal joints, especially the anterior ones, rufous (occasional specimens have a greater proportion of legs pale); long hairs of body and legs pale, those of head darker; wings chiefly hyaline.

Female.—The female differs in having the shorter hairs of head pale and the wings smoky to black.

Length of wing, 7–9 mm.

The inner spur of front tibia varies more in length than is usual in other species, sometimes being only about half the length and scarcely deserving to be called subequal to the outer.

The known range of the species extends from New Hampshire, Michigan, and Colorado to Missouri and Virginia. Specimens from most parts of this range have been examined in connection with the preparation of this paper.

BIBIO FRATERNUS Loew.

Bibio fraternus LOEW (H.), Dipt. Amer. sept. indig., Cent. 5, No. 8, 1864. Compl. Work, p. 216 [District of Columbia].

Male.—Head, body, and coxae black, the eyes with dark and other parts with pale hair; femora and succeeding leg joints yellow to rufous, dark-tipped; wings chiefly hyaline, anterior veins and stigma dark.

Female.—The female differs in having shorter hairs generally, all of them pale; anterior parts of pronotum and mesonotum, except for three more or less distinct dark vittae, sometimes part of pleura and the coxae, yellow to rufous; wings fumose.

In both sexes, the front tibiae are almost wholly black, the rufous spurs subequal, and the hind metatarsi equal or exceed in length the succeeding 3 tarsal joints combined.

Length of wing, 5–6.5 mm.

Specimens examined come from a range with the following States at its extremes: Connecticut, Iowa, Tennessee, and Virginia.

BIBIO FUMIPENNIS Walker.

Bibio fumipennis WALKER (Francis), List of the Specimens of Dipterous Insects in the Collection of the British Museum, pt. 1, 1848, p. 122 [St. Martin Falls, Albany River, Hudson Bay].

Male.—Head, body, and coxae black, the head with copious, long, dark hair, the other parts with same, pale yellow to grayish; legs rufous, the femora dark-tipped, the tibiae hardly so, except front ones each of which have a brownish annulus at base of the very unequal rufous spurs, last two or three tarsal joints dark, hind femora and tibiae clavate, and hind tarsi somewhat enlarged; wings yellowish fumose, deeper costally where the veins and stigma are brown. Length of wing, 7.5–8 mm. Female not seen.

Two males from Mount Washington, New Hampshire, Slosson, and Banff, Alberta, Sanson, identified by Coquillett may be this species; the original description does not refer to the anterior tibial spurs, hence without access to the type specimen identification can not be positive.

BIBIO HOLTII, new species.

Male.—Spurs of front tibiae very unequal; hind legs elongate, their femora and tibiae clavate, and metatarsi slightly enlarged; eyes reddish with copious, rather long black hair, occiput with long dark hair; body and coxae black with rather sparse, long pale (reddish to grayish) hair; femora except their extreme ends bright rufous, remainder of legs dark reddish-brown to black, femora with rather long, pale, and tibiae and tarsi with shorter dark hair; wings dusky fumose, both veins and membrane distinctly darker on costal half of wing; stigma brown.

Length of wing, 7 mm.

Type.—Cat. No. 24700, U.S.N.M. A male from Graham Mountains, Arizona, July 25, 1914, E. G. Holt (U.S.N.M.).

A paratype male, Geneva Park, Grant, Colorado, altitude 10,000 feet, August 19, 1914, differs in having the femora yellow, and in being smaller, the wing measuring 5.5 mm., E. C. Jackson (Biological Survey). Another paratype male from Custer, South Dakota (Aldrich), agrees well with the type; length of wing, 7 mm. This species is named for the collector of the holotype, Mr. E. G. Holt, who has collected many interesting and novel insects in the western States, a particularly notable lot of which were obtained in the Graham Mountains.

BIBIO HUMERALIS Walker?

Bibio humeralis WALKER (Francis), List. Dipt. British Mus., pt. 1, 1848, pp. 121–2 [Nova Scotia].

Female.—Head and body black, complete transverse inverted V-shaped band along suture between pronotum and mesonotum,

pleura largely, and legs, pale rufous; tibiae faintly brown-tipped and terminal tarsal joints dusky; all hair pale; wing yellowish fumose deepest along costa where the veins are nearly black, remaining veins and stigma brown. Length of wing, 8.5 mm.

A single female from Las Vegas, New Mexico, 6,400 feet, Cockerell, identified as *humeralis* by Coquillett (U.S.N.M.).

Walker's description does not mention the front tibial spurs, hence, strictly speaking, *humeralis* is unidentifiable from the description alone. Moreover, the specimen recorded is from a region far distant from the type locality. However, considering the correlation between altitude and latitude, the distribution indicated is not impossible, and for the present it sems best to accept Coquillett's identification of the New Mexican specimen rather than to describe a new species on the basis of a single female.

BIBIO INAEQUALIS Loew.

Bibio inaequalis Loew (H.), Dipt. Amer. sept. indig., Cent. 5, No. 3, 1864, Compl. Work, pp. 213–4 [Sitka].

Bibio fumidus Coquillett (D. W.), Report on Diptera of the Commander Islands, 1899, p. 343 [Copper Island].

Male.—Head, body, and coxae black, head with copious, long, dark hair, and body and coxae with same, pale yellowish; femora swollen, dark reddish brown, the hind ones clavate, yellowish basally; front tibiae, reddish brown with base and very unequal spurs yellowish; others yellowish, dark apically, the hind ones clavate; tarsi with the last two or three joints dark, the hind ones noticeably thickened; wings yellowish fumose, deeper costally, anterior veins and stigma brown.

Female.—The female differs in having only the head black, the thorax reddish brown with indications of dark vittae, the abdomen yellow brown, all with pale yellowish hair, shorter than in male; pleura and coxae reddish brown with more or less black markings, femora and succeeding leg-joints reddish yellow, slightly darker at tips, last two or three tarsal joints dark; wings as in male.

Length of wing, 7–8.5 mm.

Specimens examined, including the type series of *B. fumidus* Coquillett, are from Unalaska, Iditarod, and Saldovia, Alaska, Copper Island and Karagi Island, Kamchatka.

BIBIO LONGIPES Loew.

Bibio longpipes Loew (H.), Dipt. Amer. sept. indig., Cent. 5, No. 12, 1864, Compl. Work, pp. 217–8 [District of Columbia].

Male.—Entirely black except for the outer (and much longer) spurs of anterior tibiae, head with long dark hairs, and body, coxae and femora with long gray to reddish hair; hind legs elongate,

femora and tibiae clavate, tarsal joints thickened; wing hyaline, anterior veins and stigma brown.

Female.—The female has entire thorax, coxae and succeeding leg joints rufous, dark-tipped (tarsi sometimes chiefly dark), and the hair much shorter and all pale; wing yellowish fumose, costal cell opaque yellowish, stigma and anterior veins brown.

Length of wing, 5–8 mm.

Specimens from New Hampshire, Massachusetts, New Jersey, Maryland, District of Columbia, and Virginia have been examined; the species has been recorded also from Quebec. Two males from near Flagstaff, Arizona, October 15, 1914, E. G. Holt, having the hair of head and thorax black and of pleura, legs, and abdomen pale, are intermediate between *longipes* and *slossonae*. A specimen from Yale, Idaho (Aldrich), seems to agree in every way with *longipes*, further indication of the close relationship of this form with *slossonae*, which has so extended a range in the north.

BIBIO NERVOSUS Loew.

Bibio nervosus LOEW (H.), Dipt. Amer. sept. indig., Cent. 5, No. 4, 1864, Compl. Work, p. 214 [California].

Male.—Black, shining, eyes with dark hair, body, coaxe, fore and mid femora clothed with plentiful long gray hair; femora and succeeding leg joints rufous, tipped with black; wings smoky hyaline dusky near costa, the veins there and stigma being black.

Female.—Head and body black with short gray hair; coxae and succeeding leg joints rufous, those from femora on, dark-tipped; front tibia with basal and subapical black bands; wings dusky hyaline brown costally with black veins and stigma.

Length of wing, 6.5–8 mm.

Specimens examined are from Moscow, Idaho, and Sierra Morena Mountains, and Palo Alto, California (Aldrich); Wenatchee, Washington (U.S.N.M.).

Very similar to *B. xanthopus*, from which it differs in both sexes by the duskier wings and the front tibiae being broader in proportion to their length.

BIBIO RUFITHORAX Wiedemann.

Bib. [*io*] *rufithorax* WIEDEMANN (C. R. W.), Ausz. zweifl. Ins., vol. 1, 1828, p. 79 [Pennsylvania].

Humeral ridge, top of meso- and meta-notum rufous, head and body otherwise black, each with short concolorous hair; legs dark reddish-brown to black, pulvilli yellow, spurs of anterior tibiae very unequal; wings and veins blackish fumose darker costally, stigma almost wholly obscured. Length of wing, 8.5–9 mm.

Two females seen: Myrtle Beach, Horry County, South Carolina, April 22, 1919, E. R. Kalmbach (Biol. Survey); Paris, Texas, June

14, 1904, A. A. Girault (U.S.N.M.). The species has been recorded also from Florida.

BIBIO SLOSSONAE Cockerell.

Bibio slossonae COCKERELL (T. D. A.), Fossil Insects from Colorado, The Entomologist, vol. 42, p. 174, July, 1909. New name for *B. gracilis* Walker, 1848, not of Unger, 1841.

Bibio gracilis WALKER (Francis), List Dipt. Ins. Brit. Mus., vol. 1, 1848, p. 123 [Nova Scotia].

Male.—With head and body black, the head and thorax with copious long black hair, abdomen with the same, gray; legs brown to black, joints having a tendency to be pale basally and dark apically, the coxae and femora long haired, slender, the posterior elongate, hind femora and tibiae clavate, hind tarsi enlarged; spurs of front tibiae very unequal, rufous; wings hyaline with a slight yellowish cast.

Female.—The female differs by all the hair being short and pale and the pleura, coxae, and succeeding leg joints (except for faint dark tips) yellowish rufous; wings a little more deeply suffused with yellowish brown; stigma and anterior veins in both sexes brown.

Length of wing, 5–6.5 mm.

Specimens examined are from Unalaska, Ontario, Maine, New Hampshire, Massachusetts, Maryland, and Arizona. Only males have been identified. Is this form merely a dimorphic male of *B. longipes* Loew?

BIBIO TENUIPES Coquillett.

Bibio tenuipes COQUILLETT (D. W.), New Diptera from North America, Proc. U. S. Nat. Mus., vol. 25, p. 95, Sept. 12, 1902 [Williams, Arizona].

Head and body black, narrow, humeral ridge pale yellow; hair of eyes of male black, hair elsewhere in both sexes pale yellow to grayish, shorter on female; legs dark reddish brown, the front tibial spurs rufous, very unequal, hind legs but little longer than others, joints scarcely clavate, first joint of hind tarsus but little longer than second; wings sordid hyaline, all the veins brown. Length of wing, 4–7 mm.

Specimens examined include the type from Williams, Arizona, June 5, H. S. Barber, and numerous others from Las Vegas, New Mexico, May 4, 1904; Santa Fe, New Mexico, May 6, H. S. Barber; Boulder, Colorado, May 22, 1907, S. A. Rohwer (U.S.N.M.).

BIBIO TRISTIS Williston.

Bibio tristis WILLISTON (S. W.), in Kellogg, V. L., Insect Notes, Trans. Kansas Acad. Sci. (1891–2), 1893, pp. 113–14 [Western Kansas].

Male.—Head, body, and coxae black with boderately long black hair; femora and succeeding leg joints, rufous, tipped or more ex-

tensively obscured with darker; spurs of front tibiae rufous, very unequal; wing and veins dusky fumose, darker costally. Length of wing, 6 mm.

The female also, according to Williston, is chiefly black pilose, thus differing from most of the species of *Bibio*, and has the coxae, except front ones in part, black.

A male collected in the Graham Mountains, Arizona, at an altitude of over 9,000 feet, June 3–6, 1914, by E. G. Holt is assigned to this species.

BIBIO VARIABILIS Loew.

Bibio variabilis LOEW (H.), Dipt. Amer. sept. indig., Cent., 5, No. 7, 1864, Compl. Work, pp. 215–6 [Sitka; New Hampshire].

Male.—Head, body and coxae black, clothed with long hair varying from gray to black, chiefly the former on abdomen, pleura, and legs, and the latter on top of thorax and on occiput; sometimes wholly black pilose; femora black, the mid and hind pairs often rufous near bases (all of them sometimes almost entirely rufous); tibiae and tarsal joints rufous basally, dark apically, the subequal spurs of front tibiae rufous; wings hyaline, anterior veins and stigma brown.

Female.—The female differs in having much shorter wholly pale hair, all leg joints rufous with dark tips (coxae sometimes dark at base or even wholly black), and the wings fumose.

Length of wing, 6–10 mm.

Specimens examined were all collected along the northwest coast of North America from Corvallis, Oregon, to Yakutat, Alaska. The species has been recorded also from Quebec.

BIBIO VESTITUS Walker.

Bibio vestita WALKER (Francis), List. Dipt. British Mus., pt. 1, 1848, p. 122 [Nova Scotia].

Head, body, and legs black, clothed with black hairs, abundant and long over head, body, coxae and femora, shorter on remaining joints of legs; tibiae and tarsal joints rufous with dark tips, the last two joints of tarsi almost or wholly dark; front tibiae reddish-brown, the spurs very unequal; wings nearly hyaline, stigma and anterior veins brown, the cells bounded by latter more obscure than remainder of wing, posterior veins almost hyaline. Length of wing, 7 mm.

A male collected at St. John, New Brunswick, June 9, 1901, W. McIntosh, is identified by Coquillett as *vestitus* and probably is that species; the original description does not mention the front tibial spurs.

BIBIO XANTHOPUS Wiedemann.

Bib. [*io*] *xanthopus* WIEDEMANN (C. R. W.), Ausz., zweifl. Ins., vol. 1, 1828, p. 80 [New York].

KEY TO SUBSPECIES OF XANTHOPUS.

A. Pleura of female wholly dark; male with the hair more copious and longer, usually darker, sometimes black.................. B. xanthopus palliatus.

AA. Pleura of female often in part yellow to rufous; male with less abundant and shorter hair usually pale on thorax and abdomen.......... B. xanthopus xanthopus.

BIBIO XANTHOPUS XANTHOPUS Wiedemann.

Bibliographical reference as for species.

Male.—Head, body, and coxae black, head with black, body and coxae with usually pale yellow to grayish hair; femora and succeeding leg joints yellow to rufous, dark-tipped, the very unequal spurs of front tibiae rufous; humeral ridge, narrowly pale; wings slightly fumose, a little deeper costally, all of the veins dark, the anterior ones and stigma darkest.

Female.—The female differs by having shorter, pale hair on head, the coxae and pleura often in part yellow to rufous, pale humeral ridge more distinct, and wings more yellowish, sometimes dusky fumose.

Length of wing, 5.5–9.5 mm.

The range of this subspecies, on the basis of specimens examined, extends from Maine, Ontario, and Michigan to Pennsylvania, Tennessee, Colorado, and New Mexico. It has been reported also from Quebec.

BIBIO XANTHOPUS PALLIATUS new subspecies.

Differs from the typical subspecies in darker colors, more abundant pubescence, and somewhat greater average size. The pleura of female usually are wholly dark; the male has more abundant, longer, and darker hair, sometimes wholly black. This subspecies bears somewhat the same relation to the eastern race of *xanthopus* that *hirtus* does to *albipennis.* Length of wing, 7.5–9.5 mm.

Type.—A male, Moscow, Idaho, May 7, 1894; allotype, female mounted on same pin with type. Paratypes from Tacoma and Seattle, Washington, British Columbia and Vancouver Islands (Aldrich).

SPECIES NOT IDENTIFIED.

BIBIO ARTICULATUS Say.

Bibio articulatus SAY (Thomas), Journ. Acad. Nat. Sci. Philadelphia, vol. 3, 1823, p. 78; Compl. Writings, vol. 2, 1859, p. 69 [Pennsylvania].

Since there is no type specimen of Say's species and the original description does not refer to the length of tarsal joints, this species became unidentifiable when Lowe described *abbreviatus* with short hind metatarsi.

BIBIO BALTIMORICUS Macquart.

Bibio baltimoricus MACQUART (J.), Dipt. Exot. 5 Suppl. 1855, pp. 37–38 [Baltimore].

BIBIO BRUNNIPES (Fabricius).

Tipula brunnipes FABRICIUS (J. C.), Ent. Syst., vol. 4, 1794, p. 250 [Newfoundland].

BIBIO CANADENSIS Macquart.

Bibio canadensis MACQUART (J.), Dipt. Exot., vol. 1, 1838, p. 179 [Canada].

BIBIO CASTANIPES Jaennicke.

Bibio castanipes JAENNICKE (F.), Neue exotische Dipteren, Ab. d. senckenb. naturf. Gesellsch., vol. 6, 1867, p. 317 [Illinois].

BIBIO LUGENS Loew.

Bibio lugens LOEW (H.), Dipt. Amer. sept. indig, Cent. 5, No. 6, 1864, Compl. Work, pp. 214–5 [Winnipeg].

BIBIO NIGRIPILUS Loew.

Bibio nigripilus LOEW (H.), Dipt. Amer. sept. indig., Cent. 5, No. 10, 1864; Compl. Work. p. 217 [Winnipeg].

BIBIO OBSCURUS Loew.

Bibio obscurus LOEW (H.), Dept. Amer. sept. indig., Cent. 5, No. 5, 1864, Compl. Work p. 214 [Hudson Bay Territory]. Probably the same as *B. xanthopus* Wiedemann.

BIBIO ORBATUS Say.

Bibio orbatus SAY (Thomas), Journ. Acad. Nat. Sci. Phila., vol. 3, 1823, p. 78; Compl. Writings, vol. 2, 1859, pp. 69–70 [Pennsylvania]. See discussion under *Dilophus orbatus*.

BIBIO PALLIPES Say.

Bibio pallipes SAY (Thomas), Journ. Acad. Nat. Sci. Phila., vol. 3, 1823, pp. 76–7; Compl. Writings, vol. 2, 1859, pp. 68–9 [Pennsylvania]. Remark in connection with *B. articulatus* applies here also.

BIBIO RUFIPES Fabricius.

Tipula rufipes FABRICIUS (J. C.), Species Insectorum, vol. 2, 1781, p 410 [Newfoundland].

BIBIO SCITA Walker.

Bibio scita WALKER (Francis), List Dipt. British Mus., pt. 1, 1848, p. 122 [Nova Scotia].

BIBIO SENILIS Wulp.

Bibio senilis WULP (F. M. van der), Noglets over Noord-Americaansche Diptera, Tijdschrift voor Entomologie, vol. 12, 1869, pp. 81–2 [Wisconsin].

BIBIO STRIATIPES Walker.

Bibio striatipes WALKER (Francis), List Dipt. British Mus., pt. 1, 1848, pp. 122–3 [St. Martin Falls, Albany River, Hudson Bay].

BIBIO THORACICA Say.

Bibio thoracica SAY (Thomas), (in Narrative of an Expedition to the Source of St. Peter's River, etc., under the Command of Stephen H. Long, vol. 2, 1824, p. 368), Compl. Writings, vol. 1, 1859, p. 250. [East Florida.]

Genus DILOPHUS Meigen.

KEY TO THE SPECIES: MALES.

A. Front tibia with three series of spines ---------- **spinipes.**
AA. Front tibia with two series of spines.
B. Wings dusky to black throughout ---------- **serotinus.**
BB. Wings chiefly hyaline.
C. Rostrum [10] nearly or quite as long as antenna ---------- **stigmaterus.**
CC. Rostrum distinctly shorter than antenna.
D. Genital segment cleft half or less than half its length.
E. Genital segment cleft distinctly less than half its length.
F. Length of wing, 5–6 mm.; stigma faint ---------- **tibialis.**
FF. Length of wing, 4 mm. or less; stigma distinct ---------- **strigilatus.**
EE. Genital segment cleft about half its length.
G. Body and legs with dark hair ---------- **orbatus.**
GG. Body and legs with pale hair.
H. Hind margin of superior genital plate straight or nearly so.
I. Superior plate about as long on median line as across straight part of hind margin ---------- **breviceps.**
II. Superior plate more transverse, about four times as wide as long ---------- **proximus.**
HH. Hind margin of superior genital plate obviously concave or emarginate.
J. Superior plate gently to decidedly concave.
K. Superior plate, less transverse, about three times as wide as long ---------- **caurinus.**
KK. Superior plate more transverse, about four times as wide as long ---------- **obesulus.**
JJ. Superior plate conspicuously angulate emarginate. **emarginatus.**
DD. Genital segment cleft nearly to base ---------- **sectus.**

KEY TO THE SPECIES: FEMALES.

A. Front tibia with three series of spines ---------- **spinipes.**
AA. Front tibia with two series of spines.
B. Wings dark.
C. Thorax, coxae, and femora rufous ---------- **serotinus.**
CC. Thorax black, legs brown to black ---------- **orbatus.**
BB. Wings chiefly hyaline.
D. Rostrum nearly as long as antenna ---------- **stigmaterus.**
DD. Rostrum distinctly shorter than antenna.
E. Thorax chiefly rufous above.
F. Prothoracic comb very prominent, nearly equaling eye in height. **strigilatus.**
FF. Prothoracic comb much lower ---------- **breviceps.**
EE. Only the humeri (of upper surface of thorax) rufous.
G. Mid and hind femora dark ---------- **emarginatus.**
GG. All femora pale.
H. Mid and hind tibiae and tarsi dark. **obesulus; sectus; tibialis; caurinus.**
HH. Mid and hind tibiae and tarsi pale ---------- **proximus.**

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[10] This term refers to the chitinized portion of head below eyes, not to the proboscis, which is more or less extensible in all species.

DILOPHUS BREVICEPS Loew.

Dilophus breviceps LOEW (H.), Dipt. Amer. sept. indig., Cent. 9, No. 59, 1869, Compl. Works, vol. 2, p. 200 [New Hampshire].

Male.—Eyes with short dark hair, head and body shining black with longer pale hair; genital segment with a U-shaped cleft half its length, superior plate about as long as wide across hind margin which is very slightly convex; legs brownish black the fore femora darkest, hair of legs generally pale, tending to be darker on tarsi especially the front ones; wings nearly hyaline, veins near costa yellow-brown, stigma nearly obsolete.

Female.—Head black, basal joint of antenna in part or wholly pale; thorax yellow to rufous, sometimes touched with brown to black on pleura, front of prothorax, and scutellum; abdomen velvety brown to black above, sordid yellow to brown below; coxae and femora yellow, tibiae and tarsi pale fuscous the anterior darker, the front tarsi sometimes black; hair pale with the exception of that on front tarsi which is dark; halteres with the knob fuscous, the stalk pale; wings yellowish fumose, the veins nearly concolorous, those near costa sometimes darker; stigma large, light to dark brown.

Length of wing, 3.5–4.5 mm.

Three females from North Carolina examined and a male and female labeled Mannanattawa, June 25, 1903, W. J. Wilson.

DILOPHUS CAURINUS, new species.

Male.—Entirely shining or subshining black, eyes with copious long dark hair, hair of other parts of body and of coxae and femora long, pale; of tibiae and tarsi shorter, more bristly, tending to be darker especially on tarsi; genital segment cleft about half its length, the cleft often distinctly expanded at bottom, superior plate only about three times as long as wide along hind margin which is slightly concave; wing grayish hyaline, veins near costa and large stigma pale brown.

Female.—Head and thorax black, abdomen brown, with pale hairs; humeri, front (sometimes all) coxae, and femora yellow to rufous with pale hair, tibiae and tarsi brownish to black, color of hair corresponding to depth of coloring of joints; halteres with pale stalks and dark knobs; wings clear to yellowish hyaline, sometimes with transverse dusky clouding at level of stigma, veins near costa and stigma brownish, others nearly hyaline.

Length of wing, 4.5–6 mm.

Type.—Cat. No. 24701, U.S.N.M. A male, Popoff Island, Alaska, July 12, 1899, T. Kincaid (U.S.N.M.).

Paratypes of both sexes, Friday Harbor, Washington, July 17–23, 1905, May 29, June 1, 1906; San Juan Island, Washington, May 31, 1906, and Seattle, Washington (Aldrich).

DILOPHUS EMARGINATUS, new species.

Male.—Body shining black, legs more brownish, the front tibiæ darker; close-set hair of eyes dark, longer hair of underside of head, body and greater part of legs pale, of front tibiæ and tarsi dark; genital segment with a cleft half its length, rounded expanded at the bottom, superior plate decidedly not transverse, about as long as wide across hind margin which is distinctly angularly emarginate; wings hyaline, veins near costa brown, stigma nearly obsolete.

Female.—Humeri obscurely castaneous, thorax otherwise, and head shining black, abdomen velvety brownish black; legs rufous more or less suffused with brown, the front coxæ and femora palest; all hairs pale; wings hyaline, veins near costa and distinct stigma brown.

Length of wing, 4.5 mm.

Type.—Cat. No. 24702, U.S.N.M. Male and allotype collected at Samoa, California, May 23, H. S. Barber (U.S.N.M.).

DILOPHUS OBESULUS Loew.

Dilophus obesulus Loew (H.), Dipt. Amer. sept. indig., Cent. 9, No. 60, 1869; Compl. Work, vol. 2, p. 200 [District of Columbia].

Male.—Lower surface of head black with long pale hair, eyes with shorter more abundant dark hair, thorax and abdomen shining black with long, sparse, pale hair; genital segment with a U-shaped cleft about half its length, superior plate transverse, about four times as broad as long, its hind margin slightly concave; legs reddish brown to black, in general pale haired but hairs on tibiæ and tarsi (especially the front ones) often in part or wholly dark; wings and veins nearly hyaline, slightly fumose costally, stigma almost obsolete.

Female.—Head black with short pale hair; humeri rufous, thorax elsewhere above shining black with sparse pale hair; pleura brownish-black more or less spotted with paler; abdomen velvety brownish black with abundant pale hair; coxæ and femora (and sometimes the front tibiæ) yellow to rufous, pale haired; trochanters, tibiæ (except front pair occasionally) and tarsi, fuscous to black chiefly darker haired; wings nearly hyaline, veins near costa brown, rather large stigma nearly black. Females from western localities usually have more or less dusky clouding transversely in the wing as the level of the stigma.

Length of wing, 4–5 mm.

Specimens examined are from Plummers Island, Maryland, Great Falls and Dead Run, Virginia; Cochetopa National Forest, Colorado, and Mott, North Dakota (Biological Survey); Pennsylvania, La Fayette, Indiana, and Moscow, Idaho (Aldrich). Two males from British Columbia (U.S.N.M.) are very similar, but I do not care to record them definitely as *D. obesulus.*

DILOPHUS ORBATUS Osten Sacken.

D. [*ilophus*] *orbatus* OSTEN SACKEN (C. R.), in LeConte's edition of The Complete Writings of Thomas Say on the Entomology of North America, vol. 2, 1859, p. 70 [Florida].

In the paper of 1823 in which Say's other species of *Dilophus* and *Bibio* were described (to which several references are made in the present article) he proposed a species *Bibio orbatus*.[11] Later authors (Wiedemann, 1828, Bellardi, 1859, and Osten Sacken, 1859) have used the name *orbatus* in the genus *Dilophus*, in each case probably for a different species.

Say was perfectly aware of the characters distinguishing *Bibio* from *Dilophus*, and it has not been found necessary to shift any other of his species as between these two genera. I fail, therefore, to see the point of rejecting Say's assignment of *orbatus* to the genus *Bibio* and accepting that to *Dilophus* by Wiedemann. While Osten Sacken says "Wiedemann . . . had specimens communicated by Say before him," there is no definite evidence that such was the case. Wiedemann did not have specimens of all of Say's species and his usual remark when he had seen specimens, "In meiner Sammlung," is lacking in this instance. Even had such specimens been available to Wiedemann, the chances of transposition or error in labels are such that we could by no means accept Wiedemann's reference of *orbatus* to *Dilophus* when Say certainly was just as well informed as he with respect to the generic characters. Wiedemann's action is best regarded as a misidentification and the name *Dilophus orbatus* Wiedemann as a synonym of *Bibio orbatus* Say.

Wiedemann's action therefore does not preoccupy the combination *Dilophus orbatus* and the next description under this combination, undoubtedly referring to a *Dilophus*, should be recognized. This combination is present in the contribution of Osten Sacken, cited at the beginning of this discussion, and in the first installment of Bellardi's "Saggio di Ditterologia Messicana," both published in 1859. So far I have found no means of deciding as to priority between these works, but since Osten Sacken's name undoubtedly refers to the Nearctic form it is selected for use in the present connection.

Male.—Head, body, and legs brownish to black, mostly shining, with black hairs; genital segment with a broad cleft about half its length, superior plate half as long as wide moderately convex posteriorly; wing sordid-hyaline, yellowish near costa where the veins and stigma are pale fuscous.

Female.—Same description applies except as to genitalia and wings; latter dusky to blackish, veins darker costally, stigma large, but little darker than surrounding membrane.

Length of wing, 3.5–5.5 mm.

[11] Compl. Writings, vol. 2, 1859, pp. 69–70 [Pennsylvania].

Specimens examined are from Haulover, Capron, Biscayne Bay, Buena Vista, Palm Beach, and Miami, Florida, Baton Rouge, Louisiana, and from Texas (U.S.N.M.); Pass Christian, Mississippi (Aldrich).

The distribution of *Dilophus orbatus* Osten Sacken (the species not being known north of the Gulf Coast), casts additional doubt on the identification of it with *Bibio orbatus* Say, which was described from Pennsylvania.

DILOPHUS PROXIMUS, new species.

Male.—Head, body, and legs, piceous to black, shining, with pale hair, except on eyes, front tibiae and all tarsi; genital segment cleft, half its length, superior plate transverse, about four times as wide as long, straight or slightly concave posteriorly; wings hyaline, veins near costa and rather distinct stigma light brown.

Female.—Head and thorax except humeri shining black, and abdomen velvety brown, all with short pale hair; humeri and legs chiefly yellow to rufous, tibiae and tarsi, especially of the front legs deeper colored, sometimes black; in pale specimens the trochanters, distal tarsal joints and apices of other tarsal joints only are black, hair of legs except tarsi pale; wings hyaline, veins near costa and stigma brown.

Length of wing, 3–5 mm.

Type.—Cat. No. 24703, U.S.N.M. Male and allotype labeled "Colo." (U.S.N.M.); paratype, male and female, Hunters Creek, Wyoming, September 11, 1895 (Aldrich).

DILOPHUS SECTUS, new species.

Male.—Body shining black, legs brownish black; eyes with short, close-set, dark hair; body and legs with longer, sparse pale hair, except on tarsi where it is chiefly dark; genital segment cleft nearly to its base, superior plate about three times as wide as long, distinctly concave posteriorly; wings hyaline, veins near costa and nearly obsolete stigma yellowish brown.

Female.—Head shining black, with a few short pale hairs; thorax chiefly shining black with short sparse pale hairs, humeri yellowish-rufous and indistinct patches on pleura and scutellum yellowish brown; abdomen velvety brownish-black, with pale hairs; coxae and femora yellowish rufous; trochanters tibiæ and tarsi fuscous to black, those of anterior legs darkest; hair of legs chiefly pale except on tarsi; wings as in male, stigma somewhat more distinct.

Length of wing, 4.5–5.5 mm.

Type.—Cat. No. 24704, U.S.N.M. A male, Franconia, New Hampshire, A. T. Slosson; allotype, same data; paratype, female, White Mountains, Morrison (U.S.N.M.).

DILOPHUS SEROTINUS Loew.

Dilophus serotinus LOEW (H.), Dipt. Amer. sept. indig., Cent. 1, No. 15, 1861; Compl. Work, pp. 9–10 [Illinois].

Male.—Entirely shining black, shorter hair of eyes and longer hair of hind part of abdomen, distal parts of tibiae and of the tarsi black, of remainder of body pale; halteres black and the stalk pale; wings and veins dusky to blackish, darkest costally; stigma large; genital segment cleft about half its length; superior plate half as long as wide, its hind margin somewhat rounded and shallowly but distinctly emarginate in middle.

Female.—Head black; thorax yellow to rufous, humeri, pleura, combs, and scutellum more or less touched with black; abdomen velvety brown to black; genitalia tipped with yellow; coxae (except hind ones sometimes in part) and femora except ends yellow to rufous; trochanters, tibiae and tarsi brown to black; hair of head, body and legs to and including femora pale, of tibiae and tarsi dark; halteres and wings as in male.

Length of wing, 4.5–8.5 mm.

Specimens examined are from Kansas, Missouri, Illinois, Maryland, Virginia, and Mississippi.

DILOPHUS SPINIPES Say.

D. [*ilophus*] *spinipes* SAY (Thomas), Des. Dipt. U. S., Journ. Acad. Nat. Sci. Phila, vol. 3, 1823, pp. 79–80; Compl. Writings, vol. 2, 1859, p. 71 [Missouri].

D. [*ilophus*] *thoracicus* SAY (Thomas), Des. Dipt. U. S., Journ. Acad. Nat. Sci. Phila., vol. 3, 1823, p. 80; Compl. Writings, vol. 2, 1859, pp. 71–72 [Pennsylvania, Maryland].

Dilophus dimidiatus LOEW (H.), Dipt. Amer. Sept. indig., Cent. 8, No. 3, 1869; Compl. Work, vol. 2, p. 118 [New York].

There is considerable variation in size and color in this species, sufficient in my opinion to cover the three described forms above cited. This is the only nearctic species having three series of spines on the front tibia.

Male.—Rostrum long, extended proboscis longer than antennae; lower part of compound eyes black, upper reddish, thorax in general rufous, but prothorax, the toothed ridges, middle of pleura and scutellum black; abdomen velvety black; genital segment cleft about half its length, superior plate about three times as wide as long, hind margin rounded angulate; front and mid coxae and femora chiefly rufous; remainder of legs black; hair of head, body and legs black; halteres dusky, wings and veins dusky, darker costally.

This, the only male at hand, is of the *thoracicus* type, but it is believed that variations in this sex parallels that of females, as

noted in the succeeding description, and is sufficient to cover the color differences attributed to Say's two species.

Female.—Rostrum long, extended proboscis longer than antenna; head black; thorax yellow to rufous more or less marked with black on humeri, pleura, combs and scutellum; abdomen velvety brown to black, genitalia chiefly yellow; front and mid coxae and corresponding, sometimes all, femora yellow to rufous; tibiae and tarsi brown to black; short sparse hair on head and thorax, more copious on abdomen and legs chiefly concolorous with the surface of origin; wings and veins dusky, darker costally.

Length of wing, 5–6 mm.

Specimens examined are from New England, Minnesota, Maryland, Virginia, North Carolina, and Florida.

DILOPHUS STIGMATERUS Say.

D. [*ilophus*] *stigmaterus* SAY (Thomas), Desc. Dipt. U. S., Journ. Acad. Nat. Sci. Phila., vol. 3, 1823, pp. 79–80; Compl. Writings, vol. 2, 1859, pp. 70–71 [Missouri].

Male.—Rostrum about as long as the short antenna; eyes reddish with short dark hair; remainder of head and body shining black with a moderate amount of longer pale hair; legs varying from yellowish rufous to brownish black with abundant pale hair; genital segment with only a shallow cleft, superior plate about three times as wide as long, the hind margin moderately convex; knob of halteres dark, stalks pale; wings nearly hyaline, veins of costal region and small rather indefinite stigma brown.

Female.—Rostrum about as long as the short antenna; extended mouth parts three times as long; head black the rostrum sometimes yellow to rufous; thorax yellow to rufous, combs, pleura and scutellum more or less touched with darker; abdomen velvety brown, genitalia more or less tipped with yellow; legs yellow to rufous, spines of front tibiae and tips of tarsal joints (apical joints of tarsi sometimes entirely) black; knob of halteres dark, stalk pale; wings and veins yellowish hyaline, veins of costal region and large distinct stigma brown.

Length of wing, 3.5–5 mm.

Specimens examined are from Wisconsin, Colorado, and New Mexico.

DILOPHUS STRIGILATUS, new species.

Male.—Shining black (legs sometimes brownish), with sparse pale hair; eyes reddish with short erect black hair; stalks of halteres pale; wings hyaline, veins near costa, and stigma dark brownish to black; genital segment cleft somewhat less than half its length, approaching in this respect *D. tibialis*, from which it differs in smaller size—wing 4 mm. or slightly less, as contrasted to 5–6 mm. in the former.

Female.—Similar to *D. breviceps* in coloration, but distinguished from this and other species by the conspicuous development of the prothoracic comb; head black; rostrum of ordinary length; thorax rufous, touched with black on pleura, and combs, the anterior of which is very strongly developed, with long stout teeth, height of comb nearly equal to length of eye; abdomen brown, darker basally; coxae and femora chiefly rufous, trochanters, ends of femora, tibiae and tarsi black; hairs pale except on tarsi and to some extent on tibiae; halteres with dark knob and pale stalk; wings yellowish to dusky fumose, veins near costa and large stigma dark brown. Length of wing, 5 mm. or slightly less.

Type, a female from Catalina Island, California, Baker (U.S. N.M.). Paratypes include a female, with same data, and numerous specimens of both sexes from Mount Lowe, July 3, 1917, and Mount Wilson, California (Aldrich). A female from Palo Alto, California, May 1, 1906, also is included here, but is not made a paratype; it is somewhat intermediate in characters between *strigilatus* and *occipitalis.*

Type.—Cat. No. 24705, U.S.N.M.

DILOPHUS TIBIALIS Loew.

Dilophus tibialis LOEW (H.), Dipt. Amer. sept. indig., Cent. 9, No. 61, 1869; Compl. Work, vol. 2, p. 200 [Sitka].

Male.—Head, body, and legs brownish to black, chiefly shining, with copious, rather long pale hair; genital segment cleft only about one-fourth its length, superior plate almost straight across hind margin; wings and veins nearly hyaline, membrane somewhat fumose costally, veins brown; stigma nearly obsolete, the vein running through it distinct.

Female.—Head, body and legs with copious, rather long pale hair, as in male; head, top of thorax chiefly, pleura in part, and scutellum brownish black or black, shining; abdomen pale brown to brownish black; humeri, pleura in part, coxae (at least the front ones) and femora yellow to rufous; mid and hind coxae sometimes, trochanters, tibiae and tarsi brownish to black; wings as in male, the stigma a little more distinct.

Length of wing, 5–6.5 mm.

Specimens examined are from Berg Bay, Yakutat, Sitka, and Juneau, Alaska.

SPECIES NOT IDENTIFIED.

DILOPHUS FULVICOXA Walker.

Dilophus fulvicoxa WALKER (Francis), List Dipt. British Mus., pt. 1, 1848, p. 117 [St. Martin Falls, Albany River, Hudson Bay].

DILOPHUS LONGICEPS Loew.

Dilophus longiceps LOEW (H.), Dipt. Amer. Sept. indig., Cent. 1, No. 14, 1861, Compl. Work, p. 9 [Illinois].

DILOPHUS OCCIPITALIS Coquillett.

Dilophus occipitalis COQUILLETT (D. W.), in Baker, C. F., Reports on Californian and Nevadan Diptera, I, Invertebrata Pacifica, vol. 1, p. 20, February 10, 1904 [Claremont, Calif., type No. 7669, U.S.N.M.].

This probably is a synonym of *D. breviceps* Loew. The female type supports this belief, but associated sexes from the type locality should be examined before a definite statement is made on this synonymy.

DILOPHUS PUSILLUS Wiedemann.

Dilophus pusillus WIEDEMANN (C. R. W.), Ausz. zweifl. Ins., vol. 1, 1828, p. 77. [United States?].

DILOPHUS SERRATICOLLIS Walker.

Dilophus serraticollis WALKER (Francis), List Dipt. British Mus., pt. 1, 1848, p. 117 [St. Martin Falls, Albany River, Hudson Bay].

This species has been identified by subsequent authors from New York, Colorado, and Alaska, but on color characters only.

INDEX.

This index includes all the generic and specific names treated in this paper. Generic names are in bold face type, valid specific names in roman and synonyms in italics.

A REDESCRIPTION OF THE TYPE SPECIES OF THE GENERA OF COCCIDAE BASED ON SPECIES ORIGINALLY DESCRIBED BY MASKELL.[1]

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INTRODUCTION.

As may be noted from the appended bibliography, W. M. Maskell, registrar of the University of New Zealand, began the publication of papers on the family Coccidae in the year 1879, and from that date until his death in 1898, an almost uninterrupted series of studies on the species of this family was produced by him, one or more articles, usually of considerable length, appearing annually except in the years 1881, 1883, 1886, and 1888, to the number of more than 40. The earlier work was confined to the Coccid fauna of New Zealand, but before long specimens from Australia began to come to Maskell for determination, and before his work ended he had described numerous new species from that continent, from various Polynesian islands, from China, Japan, and India, from South Africa, and even from North and South America. In the course of these studies Maskell brought together a large collection of insects of this family, amounting to 597 numbers, most of which represent unduplicated species. This collection includes unstained slide mounts of nearly all the species present, and in most cases unmounted material of the same species. Unfortunately Maskell had or retained only very small quantities of unmounted material in his own collection with a majority of the species.

Recognizing the absolute necessity for a reexamination of this collection in the light of modern concepts if the classification of the Coccidae was to develop properly, Dr. C. L. Marlatt, Assistant Chief of the Bureau of Entomology, instituted negotiations looking to its loan for study purposes in 1906. These were continued between Doctor Marlatt, Dr. L. O. Howard, Chief of the Bureau, and Mr. T. W. Kirk, at present director of the horticultural division of the

[1] This paper was completed and presented for publication before the appearance of MacGillivray's "The Coccidae," and in consequence makes no attempt to discuss the genotypes of some seventeen new Diaspine genera established in that work for various species described by Maskell.

New Zealand Department of Agriculture,[2] and the generous recommendations made by the last to the New Zealand authorities so resulted that the final consignment of the collection reached Washington in 1909. Studies on the collection were begun under the direction of Doctor Marlatt immediately after its arrival, and various notes were made and photographs taken of the more important species, but uncontrollable circumstances have, up to the present, prevented the extended critical study of the species which is much needed to further the classification of the Coccidae, and have also prevented the preparation for publication of such notes and studies as had been made previously.

When an opportunity recently presented itself to the writers to undertake definite work on this collection, it was decided, after some consideration, that the redescription and redefinition of the different genera based on Maskellian species was the most immediately important work which could be done, in spite of the fact that it required studies of genera scattered promiscuously through the whole family, and gave little or no opportunity for correlative classification in any group. These studies have certainly opened up more questions than they have been able to settle; however, it is hoped and believed that they will further the beginning which is being made in the study of the classification of this diffcult family along lines leading away from the superficial and conspicuous characters heretofore depended upon to indicate relationships, and toward those fundamental similarities and differences, often minute, in the structure and biology of the species, which must sooner or later be relied upon if a true classification is to be developed.

In the following descriptions, and particularly in the diagnoses of the genera, the writers have, in all probability, overemphasized many structural details which will be found on extended comparative study of the different groups to have little value for generic differentiation. The field is so large that a thorough knowledge of the comparative anatomy of the members of the family can only come in piecemeal fashion, and it has in consequence been considered preferable to err through the inclusion of unnecessary details rather than through the omission of possibly important facts.

The studies of the type species have been confined almost entirely to the various stages of the female, and principally to the adult and the first-stage larva. While there is no reason for believing that a study of every stage of both sexes of a species will not contribute something to a knowledge of its relationships, practical considerations, chiefly the question of the volume of this paper, the fact that the two stages emphasized are the ones most frequently obtained in collections, and the fact that in the case of the male sex there is no

[2] Recently retired.

definite basis for description or diagnosis, have influenced the limitation noted. As Maskell has in most cases described the superficial appearance of the insects named by him quite fully, this phase of each species has also been very largely ignored, and special emphasis has been laid on the morphological characteristics in the following descriptions, which are to that extent supplemental to those of Maskell.

Many of the opinions regarding the classification of the Coccidae expressed by Maskell in the course of his work appear to be excellent, and it can only be regretted that he did not correlate such ideas with a much higher degree of accuracy in the course of his descriptive studies. It is certainly safe to state that a majority of the Maskell descriptions which have been examined in the course of this work contain actual errors, not of omission, but of statement of anatomical fact, these occurring so frequently that it has not been considered desirable to call attention in the body of a description to the fact that Maskell described a structure as having certain characteristics, while these prove on reexamination to be different. Therefore, where the following descriptions differ in detail from those of Maskell it may be accepted as a rule that due consideration has been given to Maskell's statements and that the differences result from a study of specimens of the species involved. Besides this, as will be noted in the cases of *Erium* and *Anoplaspis*, Maskell has confused other coccidologists by misidentifying specimens examined by him, and by sending out such incorrectly determined specimens as examples of species described by him.

In some instances the Maskell material has been so scant that it has been necessary to rely upon recent redescriptions of the species in question for more or less of the information given. In other cases, from the same cause, it has been necessary to supplement the Maskell specimens with others evidently of the same species from other sources. Wherever it has been possible, however, the following descriptions and figures have been prepared from Maskell's type material. The genera and species described here are listed in the order given in the Fernald Catalogue of the World, 1903, although in many cases a different position within the family from that given in this catalogue has been indicated. For compactness no references given in that catalogue are repeated, and only those subsequent to it that appear to have a definite bearing on the genus involved.

It is hoped that this paper will be the first of a series discussing the species of this very important collection.

Thirty-seven genera and subgenera are described and discussed in the following pages, besides which it has been necessary to describe one new species. Wherever possible, the writers have added notes on the species other than the type which have been included in a genus,

have expanded the generic diagnoses accordingly, and have also made suggestions as to the possible relationships of the genus. Unfortunately little or nothing of this sort could be contributed with far too many of the genera.

The text figures showing the structural characteristics of the various species have been prepared by the junior author.

DESCRIPTIONS OF GENERA AND SPECIES.

Family COCCIDAE.

Subfamily MONOPHLEBINAE.

Genus MONOPHLEBULUS Cockerell.

Plate 1, fig. 1.

Genotype.—Monophlebus fuscus Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 19.

This genus was established by Prof. T. D. A. Cockerell in 1902, on the basis of the presence of 7-segmented antennae in the adult female, and with only the single included species, which must therefore be the type species.

This species is now represented in the Maskell collection by three slides, two each with a single larva, one dated 1892, the other 1894, and one with an antenna, a leg, and a portion of the derm of the adult female dated 1892, and by a single unmounted female with the Maskell No. 286. It is possible to obtain a little light on the characteristics of this species from the larvae and the pieces of the adult female, but few structures may be described in detail.

Adult female.—Elongate ovate, much shriveled when dry, body more or less covered by white secretion and with numerous glassy threads protruding from this secretion, especially along the margin where they form small bundles; antenane 7-segmented, varying from the normal monophlebine type only in a reduction of the number of segments from that usually present and in the shortening of the individual segments; legs normal monophlebine type, tarsal digitules represented only by the stubs; mentum not available for examination; spiracles not available for examination; derm, so far as can be determined from the very small piece available, with at least three types of pores, two circular, one smaller, apparently flat, with trilobed center and an oval pore between each two lobes and the surrounding ring, the other larger, apparently more heavily chitinized, normally with a larger center surrounded by a circle of several somewhat smaller pores, but this arrangement variable, so there may be one large pore and two or three smaller pores in the center of the pore circle, the third pore type large, heavy, trilocular tubular ducts, these

secreting the glassy threads; derm with two types of setae and scattered stout lanceolate spines, some of the setae slender with a definite basal collar, others, more numerous, relatively stout at base, then tapering gradually to a very slender tip, the basal collar on these

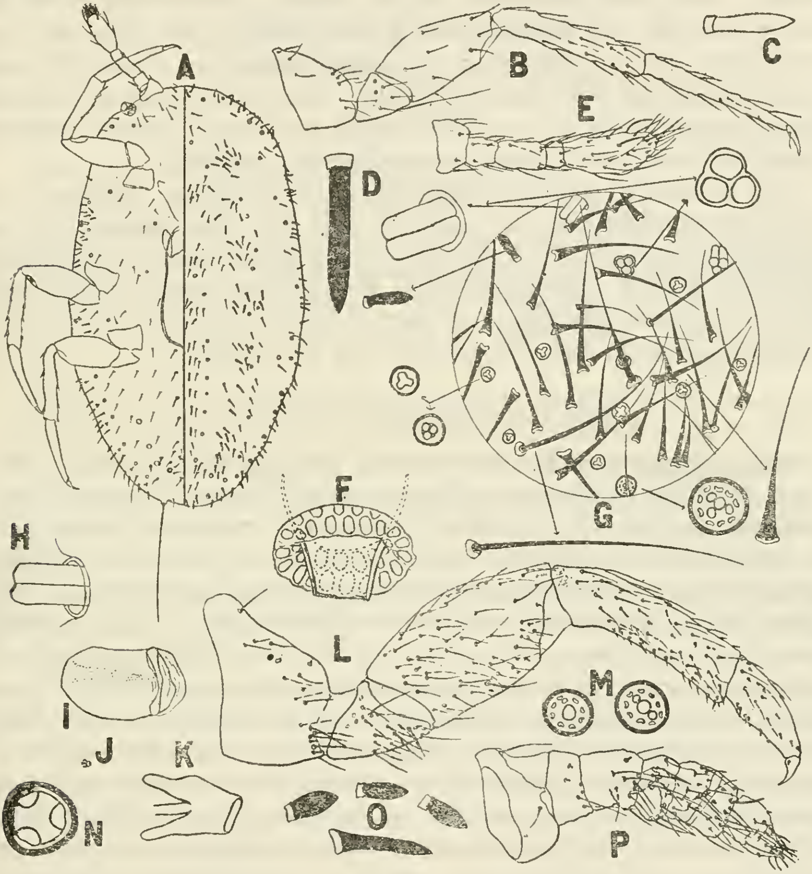

FIG. 1.—MONOPHLEBULUS FUSCUS (MASKELL). A. LARVA, OUTLINE, ×57.5; B. LARVA, MIDDLE LEG, ×115; C. AND D. LARVA, DORSAL SPINES, ×640; E. LARVA, ANTENNA, ×115; F. LARVA, ANAL RING, ×335; G. ADULT FEMALE, SECTION OF DERM, ×230, WITH ENLARGED DETAILS OF SETAE, × 335, AND OF SPINES, PORES, AND DUCTS, × 640; H. LARVA, TRILOCULAR DUCT, ×640; I. LARVA, THORACIC SPIRACLE, ×335; J. LARVA, ABDOMINAL SPIRACLE, ×335, SHOWING DIFFERENCE IN SIZE; K. LARVA, ABDOMINAL SPIRACLE, ×1500; L. ADULT FEMALE, LEG, ×50; M. ADULT FEMALE, DERM PORES, ×640; N. LARVA, TRILOCULAR DISK PORE, ×1500; O. ADULT FEMALE, DERM SPINES, SHOWING VARIATION, ×335; P. ADULT FEMALE, ANTENNA, ×57.5.

very small; anal opening not available for examination; ventral cicatrices not available for examination.

Intermediate stages.—None available for examination.

Larva.—Elongate oval, antennae rather stout, 5-segmented, the terminal largest; legs normal, claw with digitules and denticle; with two thoracic and seven abdominal pairs of spiracles, the latter simple;

derm with trilocular center circular pores arranged in four longitudinal rows dorsally and two rows ventrally, and in addition with thirteen pairs of the heavy short-tubular marginal ducts, each duct trilocular and giving off three glassy filaments which form a single thread; derm with five more or less distinct double rows of stout spines dorsally, one median, one on each margin, the other two intermediate, each accompanied by slender setae, and ventrally with rather numerous but scattered slender setae; anal opening a short tube surrounded by a pore collar; with four small circular ventral cicatrices on each half, these curving forward and out.

The following generic diagnosis has been drawn up from the preceding description, and includes only the type species, as the writers are unable at this writing to cite any other species as belonging definitely with *M. fuscus*, although *Monophlebus crawfordi* Maskell and var. *pilosior* Maskell seem very closely related and may prove on thorough study to be congeneric with *M. fuscus*.

GENERIC DIAGNOSIS OF MONOPHLEBULUS.

Monophlebine coccids; adult female elongate ovate, covered with loose secretion containing numerous glassy threads; probably not secreting an ovisac; antennae 7-segmented, legs well developed, normal; with two pairs of thoracic and seven pairs of abdominal spiracles; derm with two sorts of circular multilocular disk pores, and large trilocular tubular ducts; with slender setae, large tapering setae, and stout lanceolate spines; condition of anal opening and ventral cicatrices not known; intermediate stages not known; larva elongate oval, antennae 5-segmented; legs normal, claws with digitules and denticle; with two pairs of thoracic and seven pairs of abdominal spiracles; body with longitudinal rows of trilocular disk pores and with a marginal row of large trilocular tubular ducts around the whole body; derm with dorsal and marginal rows of stout spines, and with slender setae dorsally and ventrally; anal tube short, surrounded by a pore collar; four pairs of ventral circular cicatrices, and a single pair of long differentiated terminal setae.

This genus appears, on the basis of such study of other Monophlebine genera and species as has been possible, to be more closely related to the group including *Walkeriana*, *Lophococcus*, and *Aspidoproctus*, than to any others, although it does not possess so great a variety of either glands or spines in its derm as do these other genera, and there appears to be no tendency towards the development of the internal pouch or marsupium, which is also found in the latter genera.

Besides the type, one other species, *M. townsendi* Cockerell, has been proposed for inclusion in this genus, but this has already been

shown to have been placed on the basis of an antenna having two terminal segments broken off, giving the appearance of 6-segmented antennae, when in reality eight were originally present, and it has in consequence been removed to *Drosicha.*[3]

Subfamily MARGARODINAE.

Genus COELOSTOMIDIA Cockerell.

Plate 1, fig. 2.

Genotype.—Coelostoma zealandica Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 30.

Coelostomidia is a new name proposed by Professor Cockerell as a substitute for *Coelostoma* Maskell, the latter genus being preoccupied. The genus was first established under the latter name by Maskell in 1880 with the single included species *C. zealandicum*, which therefore stands as the type.

This species is at present represented in the Maskell collection by seven slides, one of " young insects from Muhlenbeckia, Dec. 1879," one of " under side of female, 3d stage from Muhlenbeckia, Feb. 4, 1880," one of " female 2d stage from Muhlenbeckia Feb. 7, 1880," one of " female 2d stage 1889," one of " antenna of female, Apr. 1890," one of " adult female, 1891," and one of " intermediate stage of male, 1891," and by a number of unmounted specimens, including males, females, and a number of the tests of immature stages, all of the latter bearing the Maskell No. 98.

If the statement of the published original description to the effect that it was read June 5, 1879, is correct, none of these specimens can be considered as true type specimens of the species, but it does seem quite probable that the specimens on slides dated 1879–80 represent individuals from the same colony as those on which Maskell based his original description, and consequently will be satisfactory for redescriptive purposes.

Adult female.—Elongate oval, broadest behind the middle; antennae 11-segmented, stout, tapering, the intermediate segments wider than long; legs normally developed, stout; mouthparts wanting; with two pairs of thoracic and seven pairs of large tubular abdominal spiracles, the later without the pore collar found in the intermediate stage, the posterior pair placed behind and at some distance from the anal ring; derm thin and transparent, the setae relatively much more numerous than the pores, in contrast to the condition in the second stage, with only the multilocular disk type of pore present, and these of only one sort, with a chitinized outer band, a circle of numerous loculi, and a cluster of unequally developed central loculi; derm setae

[3] See Philippine Journ. Sci., vol. 17, 1920, p. 157.

FIG. 2.—COELOSTOMIDIA ZEALANDICA (MASKELL). A. LARVA, PORE, ONE TYPE, ×640; B. LARVA, PORE, SECOND TYPE, ×1500; C. LARVA, OUTLINE FROM BENEATH, ×57.5; D. LARVA, MIDDLE LEG, ×115; E. INTERMEDIATE STAGE FEMALE, DERM SETA AND SPINE, ×335; F. LARVA, ANTENNA, ×115; G. LARVA, THIRD TYPE OF PORE, IN TWO PLANES, ×1500; H. INTERMEDIATE STAGE FEMALE, VENTRAL PORE, ×640; I. SAME STAGE, ANAL TUBE, ×57.5, WITH DETAILS, ×640; J. ADULT FEMALE, PORTION OF DERM, ×165, WITH DETAIL OF SETAE, ×335, AND OF PORES, ×1500; K. LARVA, ANAL TUBE, ×335; L. LARVA, POSTERIOR ABDOMINAL SPIRACLE, ×500; M. INTERMEDIATE STAGE FEMALE, ABDOMINAL SPIRACLE, ×165; N. SAME STAGE, THORACIC SPIRACLE, ×165; O. LARVA, LATERAL ABDOMINAL SPIRACLE, ×500; P. LARVA, THORACIC SPIRACLE, ×500; Q. INTERMEDIATE STAGE FEMALE, MULTILOCULAR DISK PORE, TWO VIEWS, ×1500; R. ADULT FEMALE, ANAL TUBE, ×57.5; S. ADULT FEMALE MIDDLE LEG, ×30; T. ADULT FEMALE, ANTENNA, ×30; U. INTERMEDIATE STAGE FEMALE, DISK PORE, SECOND SORT, ×1500; V. ADULT FEMALE, SPIRACLES, THORACIC TO LEFT, ABDOMINAL TO RIGHT, ×115; W. INTERMEDIATE STAGE FEMALE, ANTENNA, ×115; X. SAME STAGE, SMALL SIMPLE PORE, TWO VIEWS, ×1500; Y. SAME STAGE, MIDDLE LEG, ×115; Z. SAME STAGE, THIRD SORT OF DISK PORE, ×1500.

of two types, quite similar in appearance, the size varying only slightly, with the notable exception that a little behind the antennae ventrally is a pair of long slender setae, perhaps 6–8 times the length of the adjacent derm setae; anal tube, as represented in the preceding stages, present only as a short, somewhat chitinized simple tube tapering anteriorly; no ventral cicatrices observed.

Intermediate stage female.—Shape nearly globular; antennae very short and stout, conical, apex rounded, composed of nine segments; legs much reduced, stout, tapering, the tarsal claw normally with a minute denticle, the trochanter, though greatly reduced, present and bearing a seta nearly as long as the remainder of the leg; mentum apparently two-segmented, not with three; with two pairs of thoracic and seven pairs of abdominal spiracles, each with the inner end invaginated and with a collar of pores, two deep, around it, posterior abdominal pair set very close to the anal opening, the openings of the thoracic and abdominal spiracles approximately the same size, but the former with a long chitinous bar attached; derm rather thickly set with pores, all circular, including small clear pores surrounded by a chitinized ring, multilocular disk pores, varying somewhat in size, shape, and internal composition, as shown in figures, and relatively much larger simple clear disks surrounded by a chitinous ring, the first two types numerous but scattered over both surfaces of the body, the third type placed in more or less evident transverse rows ventrally and laterally; derm with fairly numerous, small, slender setae both dorsally and ventrally, these mostly larger and stouter in the chitinized area surrounding the anal opening; anal tube opening in a large, roughly circular, chitinized area at the posterior apex of the body, long, heavily chitinized, the opening surrounded by a slight chitinous ring and immediately within this a band of heavily chitinized short-tubular pores, immediately below this a band with numerous pores presenting a sievelike appearance, below this a band of large, irregularly circular pores of indeterminate structure, then a tube of plain chitin, and finally at the inner end a band of heavy, irregular-shaped, multifaceted wax secreting plates; without traces of the ventral cicatrices of the larva, unless the numerous, large, circular ventral disk pores, already described, are derivatives of these larval structures.

Larva.—Body somewhat elongate oval; antennae well developed, compact, and stout, the apical segment much the largest, but not conspicuously so, 6-segmented; legs normal, the claw with a large denticle, and a pair of slightly knobbed digitules that surpass the tip; with 7 pairs of large abdominal spiracles and two pairs of differently shaped thoracic spiracles; body, both dorsally and ventrally, with numerous circular, heavy disk gland pores, the central loculi of which vary in number from 3–6; derm with rather numerous small

slender setae, each set in a collar; anal tube distinctly chitinized, the end with a double collar of pores; apex of abdomen with a single pair of long differentiated setae, these perhaps a fourth the length of the body; with three rather large, circular, ventral cicatrices, the median slightly larger than the laterals.

Cotype.—Cat. No. 24755, U. S. N. M.

Besides the slides already listed the Maskell collection contains one other, marked "from R. Raithby, Reefton, 1891," an adult female which appears to be identical with the adults of *C. zealandicum*, except that it has a small thickening or tubercle between the anterior legs that strongly resembles a much reduced mentum. That this might easily be such a structure is shown by some recently published observations on the variability in the extent of the development of the mouth parts in certain related species.

Of the four other species left in this genus, according to the arrangement in the Fernald Catalogue, *C. assimilis* (Maskell) has been made the type of a subgenus, and will be discussed next. *C. wairoensis* (Maskell) is known only from the male, and a comparison of this male with that of the type indicates that its assignment to the genus is questionable, particularly in view of the great increase in the number of the tarsál digitules, as many as 24 being present on each tarsus, according to Maskell. An examination of the type slides of *C. compressa* (Maskell) shows that its placing in this genus is likewise questionable; the larval antennae are 7-segmented and of a different type from those of *C. zealandica;* the multilocular disk pores of the immature stages are of a very different sort from any found in the genotype; the anal tube is wanting in the intermediate stage of the female, and the antennae of the adult female are 10-segmented, to mention some of the more conspicuous differences. A similar uncertainty is evident with regard to the remaining species, *C. pilosam*, and the following generic diagnosis has therefore been limited quite closely to the characters exhibited by the type species of the genus.

GENERIC DIAGNOSIS OF COELOSTOMIDIA.

Coccids of the Monophelbine-Margarodine series; adult female elongate oval, secreting a mass of cottony substance at oviposition, antennae stout, 11-segmented; legs normal; mouth parts wanting; with two pairs of differentiated thoracic and seven pairs of large simple abdominal spiracles; derm with a single type of multilocular disk pore and two types of slender setae, all abundant; anal tube short, simple; ventral cicatrices wanting; intermediate stage female globular, enclosed in a heavy protective cell; antennae and legs much reduced; mouth parts present and functional; with seven pairs of

abdominal and two pairs of thoracic spiracles, all with collars of wax pores; derm with numerous multilocular disk pores, variable in detail, small simple pores, and large circular disk simple pores ventrally, these probably the ventral cicatrices; with one type of small, slender setae; anal tube large and long, with three collars of secreting pores of different types; larva elongate oval, antennae normal, 6-segmented; legs normal; spiracles rather large, with same number as in other stages, each without pore collar, but with one or two pores; anal tube small, with double pore collar; derm with rather numerous multilocular disk pores, varying in details, and with smaller circular simple pores; derm setae simple, slender, rather numerous; with a single pair of long differentiated posterior setae; with three ventral cicatrices in transverse curved row; adult male with 10-segmented antennae set on prominent tubercles, the hairs not arranged in definite whorls; head with a prominent lamina between antennae; abdomen without caudal or lateral tassels, the sheath of the penis long conical, tapering almost to a point.

Genus ULTRACOELOSTOMA Cockerell.

Genotype.—Coelostoma assimile Maskell.

Reference.—Cockerell, The Entomologist, vol. 35, 1902, pp. 114, 258.

This was established by Professor Cockerell with the single included species on the basis of the stated absence of legs in the adult female. No other species have been added subsequent to its establishment.

The type species is represented in the Maskell collection by five slides, one of "larva, Feb. 4, 1890," one of "2nd Stage female, Sept. 1889," one of "antenna of 2nd stage female, Feb. 4, 1890," one of "adult female, Apr. 2, 1890," and one of "adult female, 1891."

Adult female.—Nearly globular; antennae much reduced, short and stout, composed of five segments; legs present, but much reduced, each appearing as a stout triangle with claw at apex; mouth parts wanting; with two pairs of thoracic spiracles, each with a long chitinized bar, and with seven pairs of abdominal spiracles, each with large opening, nearly as large as that of thoracic spiracles, simple, the posterior pair placed quite close to the anal tube; derm with numerous multilocular disk pores of one type, but varying in details, the centers circular to trilocular; derm with numerous rather large but delicate setae, many of which appear swollen just at base; anal opening a simple ring joined by a simple chitinized tube; no ventral cicatrices observed.

Intermediate stage female.—Nearly globular, somewhat more heavily chitinized than is the adult; antennae smaller and stouter than in adult, 5-segmented; legs present but even more reduced than

are those of adult; mentum long triangular, apparently 2-segmented; with two pairs of thoracic and seven pairs of abdominal spiracles, the former with chitinous bar as in adult, all with one or two pores, the

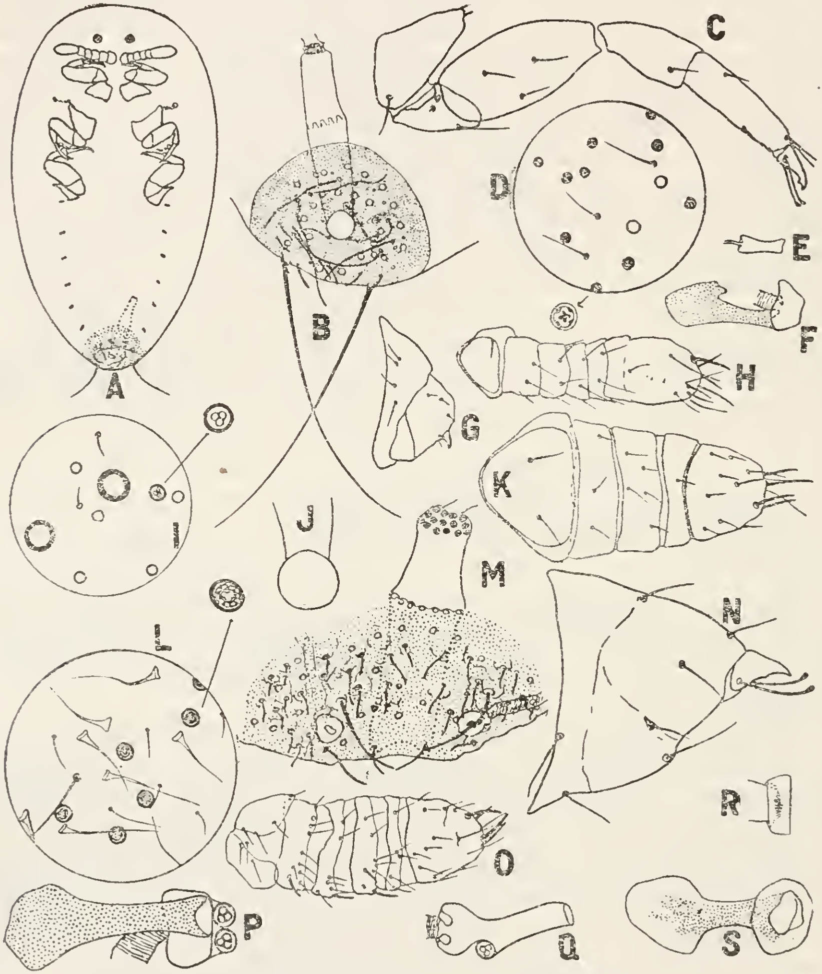

FIG. 3.—ULTRACOELOSTOMA ASSIMILE (MASKELL). A. LARVA, OUTLINE FROM BENEATH, ×57.5; B. SAME, APEX OF ABDOMEN, ×165; C. LARVA, LEG, ×220; D. LARVA, VENTRAL DERM BETWEEN LEGS, ×335, WITH DETAIL OF PORE, ×640; E. LARVA, ABDOMINAL SPIRACLE, ×500; F. LARVA, THORACIC SPIRACLE, ×500; G. INTERMEDIATE STAGE FEMALE, LEG, ×335; H. LARVA, ANTENNA, ×220; I. INTERMEDIATE STAGE FEMALE, PORTION OF DERM BETWEEN HIND LEGS, ×335; J. ADULT FEMALE, ANAL TUBE, ×165; K. INTERMEDIATE STAGE FEMALE, ANTENNA, ×335; L. ADULT FEMALE, PORTION OF DERM, ×165, WITH DETAIL OF PORE, ×640; M. INTERMEDIATE STAGE FEMALE, APEX OF ABDOMEN, ×165; N. ADULT FEMALE, MIDDLE LEG, ×440; O. SAME, ANTENNA, ×165; P. INTERMEDIATE STAGE FEMALE, THORACIC SPIRACLE, ×500; Q. SAME, ABDOMINAL SPIRACLE, ×500; R. ADULT FEMALE, ABDOMINAL SPIRACLE, ×165; S. SAME, THORACIC SPIRACLE, ×165.

posterior abdominal pair much enlarged and placed close to the opening of the anal tube; derm with numerous large circular clear pores, small circular clear pores, quadri or trilocular center pores, and multi-

locular disk pores with simple centers; derm with a few fairly short, stout setae, the circular chitinized disk at apex of abdomen bearing a pair of large setae, and a number of smaller threadlike setae; anal tube large and stout, bearing a single circle of clear pores a little nearer inner than outer end, and a band of irregular wax plate pores about three deep at inner end; no ventral cicatrices observed.

Larva.—Oval, somewhat narowed behind; antennae 6-segmented, short and stout, the club not especially conspicuous; legs normal, but rather short and stout, claw with denticle and slender somewhat knobbed digitules; mentum long triangular, 2-segmented; with two pairs of thoracic spiracles, with chitinous bar attached, and presumably with seven pairs of abdominal spiracles, these much smaller and simple; derm with rather numerous disk pores with the loculi varying from two to four, and with fewer clear pores; derm setae not numerous, fairly large, but slender; posterior apex of body with a circular chitinized area bearing a pair of long apical setae, a number of long slender, thread-like setae, slightly knobbed at tips, and a number of clear pores; anal tube well developed, opening in the middle of this chitinous area, long, striate longitudinally, with a single circle of cylindrical pores nearer inner end than outer, and a double collar of wax pores at inner end.

If it were not for Maskell's extended description of the habits and appearance of the adult of this insect, there would be some doubt as to whether the stage described by him was really adult. As was noted in the body of the description, the legs, although greatly reduced, are present in both of the late stages of the female examined, and the genus is therefore based on a morphological inaccuracy. The practical loss of the legs, together with some other structural modifications, seems to give sufficient grounds for the retention of the genus as a valid zoological unit. In this connection, mention may be made of a Japanese species, *Xylococcus alni* Oguma (*not X. alni* Florence), recently described in detail by Oguma,[4] which is said to have the legs entirely wanting and the antennae reduced to one-segmented stubs in the adult female, and which may prove on comparative study to be related to *U. assimile* (Maskell).

The generic diagnosis following is based wholly on the type species.

GENERIC DIAGNOSIS OF ULTRACOELOSTOMA.

Coccids belonging to the Monophlebine-Margarodine series; adult female enclosed in a heavy test placed in the twig axils of the host; nearly globular, antennae and legs very much reduced, the first 5-segmented; mouth parts wanting; with 7 pairs of abdominal and two pairs of differentiated thoracic spiracles, all without pores;

[4] Jour. Col. Agr. Hokkaido Imp. Univ., Sapporo, Japan, vol. 8, pt. 3, Mar. 1919, pp. 77–109.

derm with one type of multilocular disk pore and simple slender setae; anal opening a short simple tube; ventral cicatrices wanting; intermediate stage female nearly globular with apex of abdomen chitinized; antennae and legs reduced as in adult; mentum long triangular, 2-segmented; derm with bi- to quadrilocular disk pores, large and small clear circular pores, these ventrally at least, and comparatively few slender setae; with spiracles as in adult, but each with one or two pores; anal tube long and stout, with median and interior rows of pores; chitinized apical area bearing threadlike setae, one pair of large setae and the posterior spiracles in addition to the anal tube; no ventral cicatrices; larva oval; antennae short and stout, 6-segmented; legs stout, normal, claw with denticle and digitules; mentum as in intermediate stage; spiracles as in preceding stages, but simple; derm with bi- to quadrilocular disk pores and simple pores, and with some slender setae; apex of abdomen chitinized, this area bearing threadlike setae, one pair of long apical setae, and some pores; anal opening in center of this; anal tube long and stout, with pores as in intermediate stage but less developed; no ventral cicatrices.

The present confusion among the genera in this group is so great that it is practically impossible to place this genus with any degree of certainty. Except for the reduction of the legs and antennae and the failure of the adult to become active at maturity, other structural characters and habit indicate a closer relationship to *Xylococcus* than to any other genus at present known to the writers.

Subfamily PHENACOLEACHIINAE.

Genus PHENACOLEACHIA Cockerell.

Plate 1, fig. 3.

Genotype.—*Leachia zealandica* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 38.

This is another one of Professor Cockerell's genera based on a single species. It is represented in the Maskell collection by eight slides, one of "larva, 1889," one of "adult female, 1889," one of "antenna of female, 1889," one of "foot of female, 1889," one of "adult male, 1889," one of "semi-apterous male, 1890," and two of "adult female," one marked "Capleston, 1891, R. W. Raithby."

As the species has been described in detail by Maskell, the following descriptive notes may be regarded as supplemental to his work.

Adult female.—Elongate, the ends of the body tapering and rounded; antennae with a single stout sickle-shaped seta on a number of the terminal segments besides the pair on the apical one; legs with the chitinous attachment piece very long and slender, claws

with a pair of digitules, one short and flat, the other threadlike, knobbed at tip; tarsal digitules not differentiated, claw with denticle near apex; anal ring with a single interior band of more heavily chitinized pores, surrounded by a band, several pores deep, of more

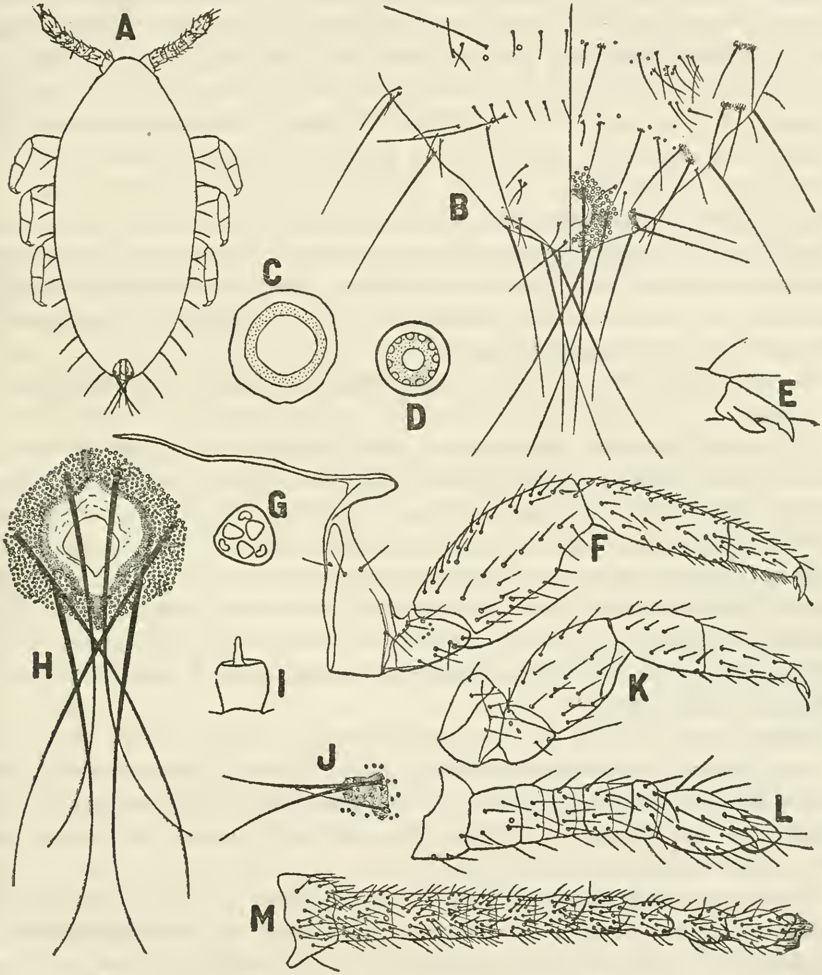

FIG. 4.—PHENACOLEACHIA ZEALANDICA (MASKELL). A. LARVA, OUTLINE, DORSAL, ×63; B. LARVA, APEX OF ABDOMEN, ×115; C. ADULT FEMALE, HEAVY CLEAR PORE, ×1500; D. SAME STAGE, MULTILOCULAR DISK PORE, ×1500; E. ADULT FEMALE, DETAIL OF CLAW, ×165; F. ADULT FEMALE, LEG, ×57.5; G. ADULT FEMALE, TRIANGULAR PORE, ×1500; H. SAME, ANAL RING, ×115; I. SAME, EVAGINATED STRUCTURE, ×1500; J. ADULT FEMALE, GROUP OF SETAE AND EVAGINATED STRUCTURES ON CHITINIZED BASE, ×115; K. LARVA, MIDDLE LEG, ×115; L. LARVA, ANTENNA, ×115; M. ADULT FEMALE, ANTENNA, ×57.5.

lightly chitinized circular pores, and within this band a set of six large anal ring setae; without the smaller hairs described by Maskell; derm dorsally with three types of gland pores, and some peculiar evaginated structures possibly representing a fourth type, these three

large, heavily chitinized, simple, clear pores, multilocular disk pores similar in appearance to those found in *Pseudococcus*, triangular pores, similar in appearance to those of *Pseudococcus* under low magnification, but showing three additional, smaller, loculi when greatly enlarged, and finally the evaginated cylindrical tubes, constricted and with a very muoh smaller finger-like prolongation of the apex, these last grouped with the large submarginal setae; derm both dorsally and ventrally with numerous setae, varying greatly in size, and in the abdominal region, at least,, arranged in transverse segmental bands, with a much larger seta on each margin, then setae not quite so large, in transverse groups of about three or four placed just within the margin and united by a small chitinized patch, and finally slightly smaller setae singly to the number of two or three on each half of each segment; mentum distinctly 3-segmented, but the two basal segments not so conspicuously separated as indicated by Maskell's figure.

Intermediate stages.—None available for study; apparently unknown.

Larva.—Elongate, tapering at ends; antennae 7-segmented with two curved setae on apical segment and one on preapical; legs rather stout, claw with denticle and two digitules; tarsal digitules not differentiated; mentum 3-segmented; anal ring and setae much as in adult; long marginal and dorsal setae present as in adult, but the latter less numerous; these accompanied by the tiny tubular protuberances of the adult; dorsum, so far as can be determined, only with triangular pores; venter, so far as can be determined, only with multilocular disk pores.

Male adult.—While the eyes of this stage are aggregated into two linear groups, as described and figured by Maskell, there seems to be some doubt as to the propriety of characterizing them as compound; from the specimens available, little or nothing can be added to Maskell's description of this stage.

This very peculiar species has no near relatives, so far as the writers are aware, and in spite of a careful study of the limited material available, it has not been possible to link it definitely with any of the larger groups now known to exist in the family. There is much in the general appearance, the kinds of pores, the development and character of the anal ring, and the development of what may be termed pseudo-cerarii, in that they serve as supports for lateral tassels, to suggest a relationship with the Pseudococcus group of genera. The number of antennal segments, the absence of dorsal ostioles, and the absence of definite cerarii seem to be sufficient to eliminate any close relationship with the mealy-bugs, however. Similarly, the number of antennal segments, the dense hairiness of these, as well as of the

legs and body, the absence of differentiated tarsal digitules and the development of the large circular clear pores would seem to indicate some connection with the Monophlebine-Margarodine series of genera, but here again, the presence of the anal ring with setae and pores and the absence of abdominal spiracles, are sufficient to eliminate close relationship with this group as well. It has therefore been necessary to continue to consider this single species and genus as the sole representative of a distinct subfamily in the Coccidae, for which the following generic diagnosis has been prepared.

GENERIC DIAGNOSIS OF PHENACOLEACHIA.

Coccids of uncertain relationships, probably representing a distinct subfamily; adult female elongate oval, tapering at ends, covered with secretion and with lateral abdominal tassels in life; antennae 11-segmented, with numerous setae and, relatively, spines; legs well developed, with numerous small setae, tarsal claw with denticle and two differentiated digitules; tarsal digitules not differentiated from other setae; mentum 3-segmented; anal ring circular, with six large setae and a broad band of pores; derm pores of three types, triangular, with three large and three small loculi, multilocular disk, and larger heavy clear disk; with small cylindrical projections with apical nipple, in clusters, especially submarginally; body setae numerous, slender, varying greatly in size, with a few larger hairs grouped transversely; intermediate stages not known; larva elongate oval, tapering before and behind; antennae 7-segmented, the terminal segments with differentiated spines, all with numerous setae; legs rather short and stout, the claw and digitules as in adult; mentum 3-segmented; anal ring as in adult, but less developed; derm pores fewer, but much as in adult; setae as in adult, except less numerous; adult male with 10-segmented antennae, eight ocelli on each side, arranged in a curved continuous row; legs long and slender, tarsal claw nearly straight, with denticle and digitules as in female; penis sheath long-conical, rounded; apex of abdomen with a large circular group of multilocular disk pores on each side of penis, and in center of these about 4 long, slender setae.

Subfamily DACLYLOPIINAE.

Genus FRENCHIA Maskell.

Plate 1, fig. 4.

Genotype.—Frenchia casurinae Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 39.

This genus was originally described with one included species, which therefore stands as the type. Maskell later added another

species, but these two are all that have ever been placed in the genus.

The Maskell collection contains seven slides of the type species, one of "rostrum of female, 1890," one of "larva, 1891," one of "larva to show spinnerets, 1891," one of "cephalic surface of female, 1891," one of "abdomen of female, 1891," one of "female 2nd stage, 1891," and one of "adult female, 1891." Besides, there is a quantity of unmounted material, including some galls split open to show the female in position, all under the No. 125. In addition, the National

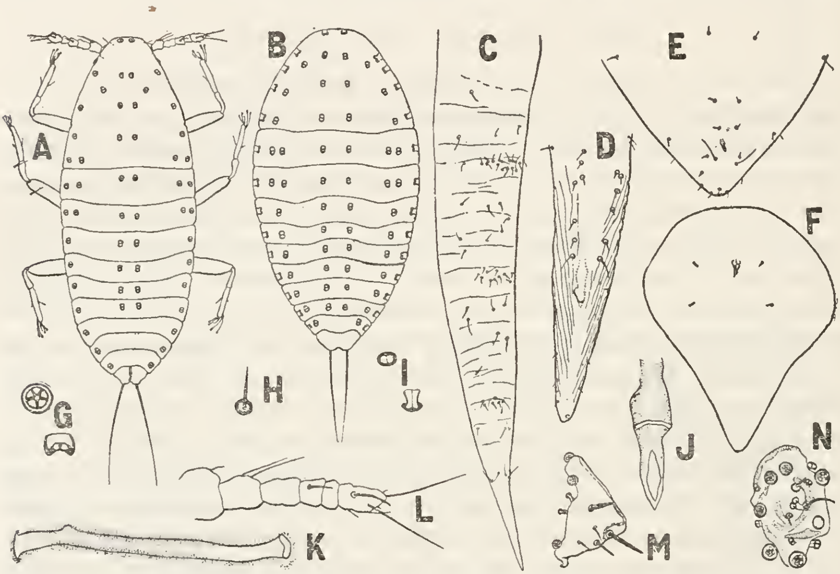

Fig. 5.—Frenchia casuarinae Maskell. A. larva, outline from above, showing pores, etc., ×115; B. the same, showing a different arrangement of the 8-shaped pores, ×115; C. "tail" of adult female, ×7.5; D. the same, detail of chitinized apex, with anal tube dotted in, ×115; E. intermediate stage female, tip of abdomen, ×335; F. the same, outline of body showing shape, ×12; G. adult female, quinquelocular disk pore, ×640; H. same, body spine, ×640; I. same, 8-shape pore, ×640; J. intermediate stage female, anal tube, ×640; K. adult female, tubular duct, ×640; L. larva, antenna, ×335; M. adult female, antenna from side, ×335; N. same, from above, ×335.

Collection of Coccidae contains a quantity of material of this species from which supplementary mounts that have aided greatly in redescription have been made.

Before proceeding to a description of the different stages of the insect, the writers desire to call attention to the following important errors in Maskell's description: 1, the tubular gall or test which Maskell describes as being excreted by the female is unquestionably woody, and a product of the plant, not of the insect; 2, the second stage as described by Maskell is in reality a first-stage larva about to molt; Maskell apparently failed to differentiate the real second

stage and the adult female, both of which occur within the gall. The following descriptive notes are directly supplementary to Maskell's extended description:

Adult female.—Of a peculiar disk-like shape, with slender tail-like abdomen; derm clearing completely when boiled in potassium hydroxide; antennae not wanting, but represented by minute cones, placed anterior to the strongly developed framework of the mouth parts; no traces of legs observed; derm with three types of gland pores, at least dorsally; with long, slender, tubular ducts angulate near bottom, with large multilocular disk pores, these, so far as noted, all quinquelocular, and with smaller, broad, somewhat obscure 8-shaped gland pores set in the bottom of a short tube, all these types more or less localized, but the arrangement not determinable due to distortion of the body on mounting; the first two types appearing very numerous and closely crowded before the development of the eggs, but much more widely scattered after the stretching of the derm due to egg development; ventrally probably with only the tiny 8-shaped pores, except for multilocular disk pores in the spiracular region; derm setae small, fairly stout, scattered in the head and thoracic regions, becoming very much larger and arranged in transverse rows in the middle of the "tail" and then quite small and spiny at its apex; gland pores apparently entirely lacking throughout most of the "tail"; anal ring represented by a chitinized tube without setae, opening a short distance before the apex of the "tail"; the latter quite heavily chitinized.

Intermediate stage female (*not* of Maskell's description).—Occurring, so far as noted, within the half-formed gall of the species; maximum length mounted on a slide about 2.5 mm.; turbinate or top-shaped, but somewhat flattened on the longitudinal vertical axis; antennae even more minute than in adult; no trace of legs; spiracles shaped much as in adult; mouthparts as in adult; gland pores apparently of only two types, multilocular disk and minute 8-shaped set at the bottoms of small tubes, both as described for the adult, both much less numerous than in that stage; derm setae very few, small, scattered, except on the conical apex of the abdomen, where they are more numerous and larger; anal tube small, swollen in the middle, without setae.

Larva.—Elongate oval, antennae apparently 6-segmented, the terminal segment with a long apical and another subapical seta, and a stout curved spine, the second segment from the last with a similar spine, the second segment with two long setae; legs rather slender, claw slender with tip strongly curved, no denticle, the two claw digitules exceeding the claw, the two tarsal digitules even longer, all these slender, slightly knobbed at apex; apex of abdomen with two

long slender setae and between these a conical invaginated tube showing at the inner end a hairless anal ring; derm dorsally and along the margin with large and prominent 8-shaped pores, each set at the bottom of a short tube, and present in two different sorts of arrangement, as shown in figure; no further evidence available to indicate whether such difference is connected with different sexes or what is responsible for it; spiracles small, each accompanied by a single multilocular disk gland pore.

One other species, *F. semiocculta* Maskell, has been placed in this genus. The mounts of this species in the Maskell collection are in such condition that it is not possible to be certain regarding the correctness of this placing. It appears to have been properly assigned to *Frenchia*, however, and may readily be separated from the type species by the fact that the "tail" is much shorter, stouter, and semicircularly rounded at apex.

The following generic diagnosis is based principally on the type species, with such modifications as would seem to include the other described species.

GENERIC DIAGNOSIS OF FRENCHIA.

Asterolecanine coccids producing peculiar woody galls on or in the host, the adult female disk-shaped, with a long tail-like prolongation of the apex of the abdomen, chitinized at tip; antennae very much reduced; legs wanting; mentum 1-segmented; anal ring developed into a short tube and without setae; derm with circular multilocular disk pores, long tubular ducts, and minute 8-shaped pores; derm setae few, small and scattered, larger and more numerous on the abdomen; no traces of spiracular spines or thickenings around anal ring; intermediate stage female flattened turbinate; antennae very much reduced; legs wanting; only multilocular disk pores and minute 8-shaped gland pores present; otherwise much as in adult; larva elongate oval; antennae apparently 6-segmented; legs slender, digitules all normal, slender, knobbed, claw without denticle; body with two long apical setae; anal ring minute, without setae, placed at bottom of invaginated tube; dorsum and sides of body with rows of large 8-shaped pores.

As indicated in the generic description, this genus is placed without question in that group of genera containing *Asterolecanium* and others, a position which has already been suggested by Mr. E. E. Green.[5] The gall-making habit and the development of the long "tail" are the only characters showing any connection with the so-called Brachyscelini while all of the morphological characters available for study indicate a definite relationship with the Asterolecaninae.

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[5] Cocc. Ceylon, pt. 4, 1909, p. 295.

Genus SOLENOCOCCUS Cockerell.

Plate 1, fig. 5.

Genotype.—*Solenophora fagi* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 58.

Maskell originally described this genus, using the preoccupied name *Solenophora*, and including two species. Cockerell later changed the name to that given above, but the type does not appear to have been fixed until its publication in the Fernald Catalogue in 1903.

The type species is represented in the Maskell collection by three slides, one of "larvae on *Fagus menziesii*, Sept., 1889," one of "female 2nd stage, on *Fagus menziesii*, Aug., 1889," one of "adult female on *Fagus menziesii*, Aug., 1889," and by a few unmounted specimens under No. 107. The National collection of Coccidae contains a portion of the type material, and additional mounts have been secured from it. The appearance and habit of the insect have been satisfactorily described and figured by Maskell.

Adult female.—Body oval, somewhat tapering behind, with a large lobe projecting out over the anal ring and lobes[6]; antennae minute tubercles bearing about 5–6 setae, and possibly very obscurely segmented; legs entirely wanting; without spiracular spines; mentum short triangular, perhaps obscurely 2-segmented; body with long-tubular ducts and 8-shaped and multilocular pores of two sizes, tubular ducts most abundant along margin of body, but also present, widely scattered, dorsally, 8-shaped pores quite variable in size, rarely appearing trilocular and all more or less deeply set into cups, the largest in a group on each half of the posterior body lobe, and joined to these groups a continuous but irregular ventral band of these pores, varying considerably in size and several deep, running clear around the body margin without interruption, and finally with numbers of these same pores, mostly quite small, scattered over the ventral surface or in more or less distinct rows on the abdomen; with clusters of small, apparently quinquelocular disk pores accompanying each spiracle, these scattered among the submarginal 8-shaped pores for some distance opposite each spiracle; also with minute circular disk pores accompanying the band of 8-shaped pores, their internal structure not determinable, but possibly tri- to quinquelocular; dorsally, near the posterior apex of the body, with two clusters of small cribriform plates, each group composed of two to three separate plates; body dorsally apparently without setae, ventrally, particularly on the posterior lobe, with a few, small, stout setae; anal ring small,

[6] The relative positions of the different structures as given in this description have been studied very carefully and are believed to be correct, but it has not been possible to segregate dorsal and ventral structures absolutely from the material at hand.

with a single row of pores and six rather short setae; anal lobes well developed, but small, elongate, rather slender, tapering, with a stout apical spine a little longer than the lobe, and three small stout setae on the inner face of each; anal ring surrounded by a simple, somewhat chitinized tube, continuous with the lobes, this produced dorsally into a median cauda, about as long as an anal lobe, tapering, and with the apex rounded.

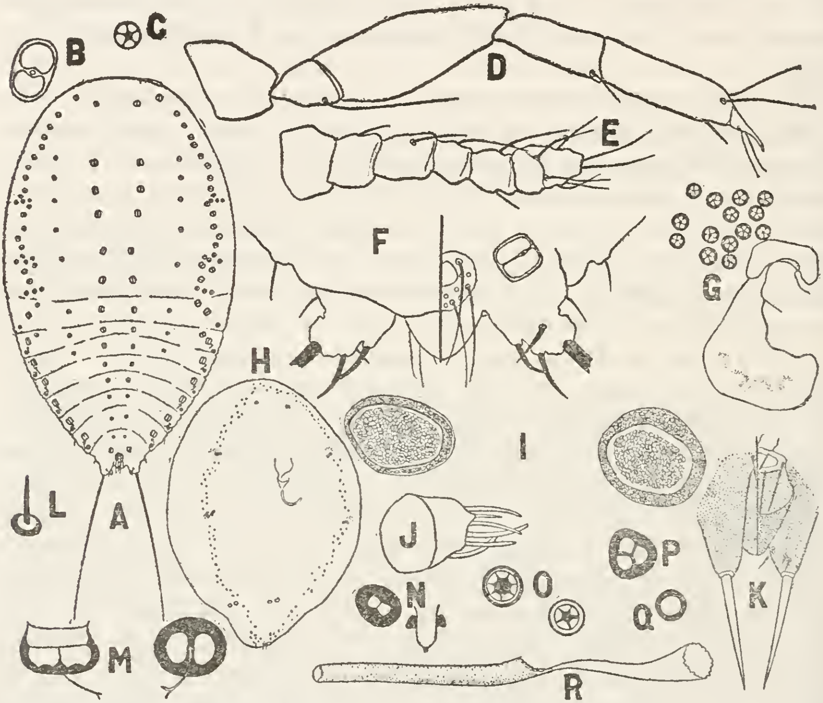

FIG. 6.—SOLENOCOCCUS FAGI (MASKELL). A. LARVA, OUTLINE, DORSAL, ×115; B. LARVA, 8-SHAPED PORE, ×640; C. LARVA, QUINQUELOCULAR PORE, ×640; D. LARVA, MIDDLE LEG, ×335; E. LARVA, ANTENNA, ×335; F. LARVA, APEX OF ABDOMEN, ×440; G. ADULT FEMALE, SPIRACLE, ×640; H. ADULT FEMALE, OUTLINE OF BODY SHOWING POSITION OF STRUCTURES, ×30; I. ADULT FEMALE, DORSAL CRIBRIFORM PLATES, ×880; J. ADULT FEMALE, ANTENNA, ×640; K. SAME, ANAL LOBES AND RING, SHOWING TERMINAL SETA AND DORSAL TRIANGULAR CAUDA, ×335; L. SAME, BODY SETA, ×1500; M–R. VARIOUS TYPES OF PORES FOUND ON BODY OF ADULT FEMALE, ×1500.

Intermediate stage female.—(from Maskell slide only) Apparently differing from the adult only in having the antennae a little more developed, in having more 8-shaped pores, occurring dorsally as well as ventrally, and in lacking the cribriform plates.

Larva.—(Maskell slide only) Oval, legs and antenna normally developed, the latter 6-segmented, body with a marginal row of large, 8-shaped pores set at the bottoms of short tubes and doubled up, each in the abdominal region accompanied by a quinquelocular disk pore, also with a dorsal median double row of the same 8-shaped pores, these diverging anteriorly and becoming much reduced in size

on the posterior abdominal segments, and between the median and marginal rows with still another row of smaller pores on each side of the body; anal lobes present, with a long terminal seta, two small spines and two setae on each; anal ring with pores and six setae; cauda present, rounded; no body spines noted; mentum 2-segmented, with indications of a second joint close to the base.

Cotype.—Cat. No. 24756, U. S. N. M.

There are 10 species besides the type that are included in this genus at present. No careful study of all of them has been possible, but from such notes as have been made, it seems probable that their inclusion in this genus is correct.

The following generic diagnosis has been based primarily on the type species, but should also cover other species which may properly be included with it.

GENERIC DIAGNOSIS OF SOLENOCOCCUS.

Asterolecanine coccids forming a horny or tough waxy test usually with a posterior tube or spout; adult female membranous, antennae reduced to tubercles; legs wanting; without spiracular spines, with dorsal cribriform plates, with well developed anal tubercles, with a median cauda above the anal ring, the latter with pores and six setae, derm setae relatively few and inconspicuous; derm with numerous 8-shaped pores, sometimes more or less definitely arranged, rather large quinquelocular pores and long tubular ducts, and finally minute clear or faintly multilocular pores; intermediate stage female quite similar to adult, but without cribriform plates; larva with 6-segmented antennae, normal legs, 8-shaped pores in longitudinal rows both dorsally and laterally, some large quinquelocular disk pores, well developed anal lobes, setae, a median cauda, and an anal ring with pores and six setae.

This genus appears to have a distinct and valid place within its subfamily, in so far as the character of the included species is concerned. The writers have had no opportunity to study the type of Comstock's genus *Cerococcus*, and are therefore unable to verify Green's indication that *Solenococcus* is a synonym of this genus, although from an examination of the available literature his conclusions appear to have been correct.[7]

Subgenus THEKES Maskell.

Plate 2, fig. 1.

Genotype.—*Eriococcus eucalypti* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, pp. 70, 74.

As Mr. Crawford's only connection with the name given above was to place it as a label on some of the specimens in his collection, it

[7] See Green, Cocc. Ceylon, pt. 4, 1909, p. 305.

seems to the writers impossible to justify the crediting of this generic name to him. In view of Maskell's statement that *E. eucalypti* "by the characters of its sac and of its dorsal conical spines, belongs to that section of the genus of which the New Zealand *E. multispinosus* may be taken as the type," it would seem to follow that if Maskell is to be credited with the authorship of the subgenus, then this latter species should be taken as the type. Actually the first definite state-

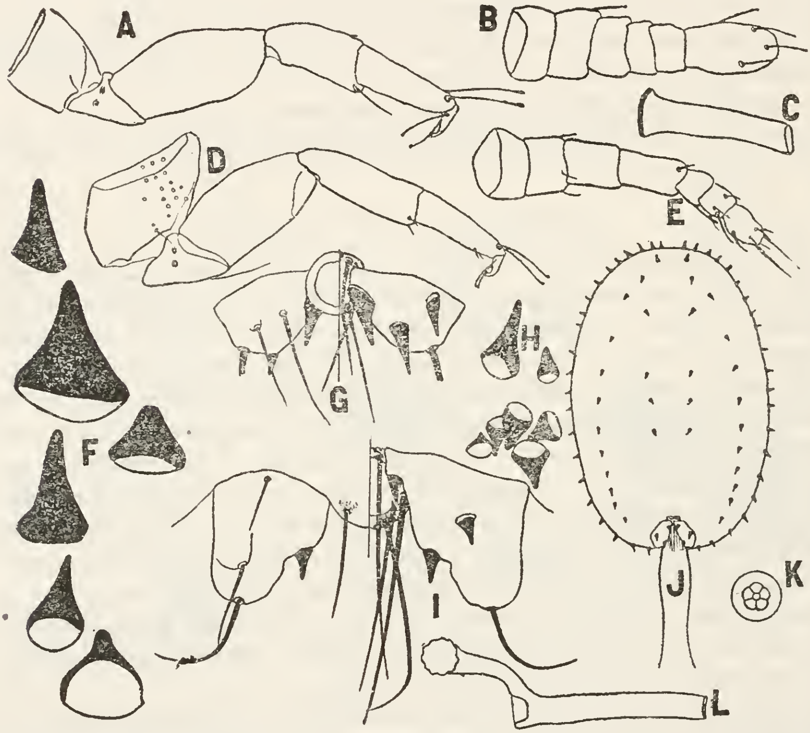

FIG. 7.—ERIOCOCCUS (THEKES) EUCALYPTI MASKELL. A. LARVA, LEG, ×440; B. LARVA, ANTENNA, ×440; C. ADULT FEMALE, TUBULAR DUCT NEAR ANAL LOBES VENTRALLY, ×1500; D. ADULT FEMALE, HIND LEG, ×165; E. SAME, ANTENNA, ×165; F. SAME, VARIOUS SPINES FROM BODY, ×640; G. LARVA, ANAL LOBES, ×440; H. LARVA, BODY SPINES (2), ×640; I. ADULT FEMALE, ANAL PLATES, ×220; J. LARVA, OUTLINE FROM ABOVE, ×165; K. ADULT FEMALE, QUINQUELOCULAR DISK PORE, ×1500; L. SAME, TUBULAR DUCT, ×1000.

ment concerning the use of the name *Thekes* to designate a group higher than a species is that of Professor Cockerell,[8] as follows: "(2) *Rhizococcus* (?) *devonensis* Green, Ent. Record, 1896, p. 260. I should certainly prefer to call this *Eriococcus devoniensis*. We already know several species of *Eriococcus* with 7-jointed antennae; the subgeneric name *Thekes* Crawford ms. is available for them." As this statement stands, it certainly implies the designation of *E.*

[8] American Naturalist, vol. 31, 1897, p. 589.

devoniensis (Green) as the type of *Thekes*. Finally the Fernald Catalogue definitely assigns the subgenus *Thekes* to Maskell and places *eucalypti* as the type. The confusion outlined above represents a condition which the writers do not desire to comment on at present, and they have therefore followed the assignment of the type as given in the Fernald Catalogue, as well as its designation of the authorship of the genus.

The type species is represented in the Maskell collection by four slides, one of "adult female (Australia), 1891," one of "details of female (Australia), 1891," one of "larvae (Australia), 1891," and one of "male pupa in sac (Australia), 1891." In addition there are three separate lots of unmounted material, all bearing No. 205 as the only data connected with them, of which two seem to be *E. eucalypti*, while the third represents some other species of the genus *Eriococcus*, which we have not attempted to place.

Adult female.—Sac and external appearance much as described by Maskell; a brownish color given off by the body when treated with potassium hydroxide; antennae of normal eriococcine form, usually 7, rarely 8-segmented; legs of normal eriococcine form, hind coxae with numerous pores, mostly on the basal half; spiracles small, not unusual; mentum very short and stout, apparently 1-segmented; derm with numerous small, long-tubular ducts with cup-shaped bases and threadlike continuation, both dorsally and ventrally, some, near the posterior apex and apparently ventral, with flat heavy bases and the threadlike continuation seemingly wanting; ventrally anterior to the anal lobes with transverse bands of tiny disk pores, apparently quinquelocular; no pores accompanying the spiracles; derm ventrally with small setae in transverse rows in abdominal region, scattered in thoracic region; dorsally and laterally with numerous very short, conical spines, these approximately uniform in diameter of base, mostly of a peculiar nipple-like shape, tending to become longer and stouter at the margins near the posterior end; anal lobes broad and stout, heavily chitinized in decided contrast to the transparent derm, the inner face strongly notched where two of the spines attach, bearing these two stout spines on the inner upper face, one basal, one about the middle, and a third sub-basally and dorsally, a long apical seta, a smaller subapical, and a still smaller basal seta ventrally; anal ring small, of normal eriococcine type, with eight setae and a double row of pores, the inner row smaller and incomplete.

Intermediate stage.—Not available for study.

Larva.—Oval, antennae 6-segmented, legs normal, digitules long and slender, slightly knobbed, claw with denticle close to apex; derm dorsally, at least at end of abdomen, with a longitudinal row of trilocular pores on each side near margin, and with long-tubular

ducts alternating with the marginal spines; margin of body with a continuous series of stout conical spines, each constricted beyond the middle, dorsally with a submarginal row of smaller spines paralleling the margin, and in the mid-thoracic region about three pairs of similar spines; ventrally with a few slender setae; anal lobes not prominent, mostly invaginated into the posterior apex of the body, broadest behind the middle, dorsally with a stout spine at base, another near middle, and a third at outer angle, apically with a long seta about two-fifths the length of the body; ventrally with two rather large setae on the inner face; anal ring with pores and six setae, these about half as long as the anal lobe setae.

Cotype.—Cat. No. 24757, U.S.N.M.

The following generic description has been prepared from the preceding:

GENERIC DIAGNOSIS OF THEKES.

Eriococcine forms, adult female enclosed in a sac with posterior opening; body oval, convex, narrowed behind; antennae 7–8-segmented; legs normal, digitules slender, slightly knobbed, claw with denticle, hind coxae with pores; derm with numerous tubular ducts with cup-shaped bases both dorsally and ventrally and with multilocular disk pores ventrally in abdominal region; dorsally and at margins with numerous very short-conical, nipplelike spines, some of these near posterior end of body more elongate; ventrally with setae in transverse rows; anal lobes well developed, but rather short and broad, each bearing three stout dorsal spines and two ventral satae in addition to the long apical seta; anal ring with pores and eight setae; young larva oval, with 6-segmented antennae, normal legs, stout marginal and dorsal spines, trilocular pores and tubular ducts; anal lobes with spines and setae as in adult, anal ring with six setae.

The writers consider it very doubtful if this subgenus has any valid standing, and at present regard it as representing nothing more than a possible key or table section within the genus *Eriococcus* which may break down entirely when the species of that genus are better known.

Genus CYLINDROCOCCUS Maskell.

Plate 2, fig. 2.

Genotype.—*Cylindrococcus casuarinae* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 84.

Maskell established this genus with two included species, and the first definite designation of type appears to have been made in the Fernald Catalogue, as referred to above.

The type species of this genus is represented in the Maskell collection by three slides, one of "larvae, 1891," one of "adult female,

1891"; one of "feet of female, 1891"; and by one unmounted female and two galls under No. 226. The National collection of Coccidae fortunately contains a few lots of this species, received from various entomologists in Australia, and from these it has been possible to prepare additional mounts for study. The following descriptions have been obtained from all the material available; as Maskell's description and figures of the gall seem quite satisfactory nothing is added on this.

Adult female.—Elongate, parallel-sided; derm clearing on boiling in potassium hydroxide, except the posterior lobe of the body, this remaining somewhat chitinized; antennae acute conical, the segmen-

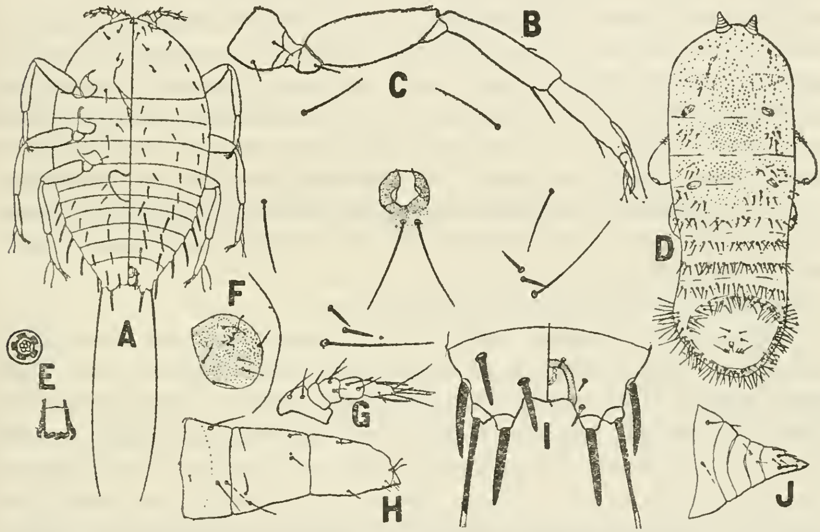

FIG. 8.—CYLINDROCOCCUS CASUARINAE MASKELL. A. LARVA, OUTLINE, ×115; B. LARVA, MIDDLE LEG, ×335; C. ADULT FEMALE, ANAL RING AREA, ×115; D. ADULT FEMALE, OUTLINE FROM ABOVE, ×17.5; E. ADULT FEMALE, DISK PORE, TWO VIEWS, ×640; F. ADULT FEMALE, TIP OF MIDDLE LEG, ×115; G. LARVA, ANTENNA, ×335; H. ADULT FEMALE, ANTERIOR LEG, ×115; I. LARVA, APEX OF ABDOMEN, ×335; J. ADULT FEMALE, ANTENNA, ×115.

tation incomplete, but perhaps 5-segmented; with two small, inconspicuous eye-spots near the antennae; anterior legs stout, fingerlike, the tibio-tarsal articulation very incompletely indicated, the trochanter apparently fused with the femur; intermediate legs represented by large evaginated pouches or sacs at the apex of which are small, somewhat chitinized plates, each bearing the rudiments of a claw, digitules and some setae; posterior legs represented by smaller lobes with the apices even less developed than in the intermediate pair; the prominence of these sacs apparently varying inversely in proportion to the extent of the distension of the body through ovarian development; mentum apparently 1-segmented, the additional seg-

ment described by Maskell not located, very short and stout triangular; spiracles not accompanied by any circular multilocular pores; anal lobes entirely lacking, their presence indicated only by two pairs of short spines, each pair accompanied by a slender seta, and each set diagonally behind the anal ring; anal ring simple, but apparently bearing two setae, placed close together just outside of the ring proper, and morphologically the lower pair; posterior apex of body more heavily chitinized, forming a somewhat circular disk, bearing numerous long setae, and, in the center, the anal ring, the setae arranged in two roughly circular irregular bands at the outside, in three transverse rows anterior to the anal ring, and in an irregular circular cluster around the ring; the anterior body segments with similar setae along the margins, these in transverse rows on each side in the abdominal segments, but irregularly scattered along the margins of the thoracic and head segments, gradually averaging smaller anteriority; derm, so far as noted, with only a single type of pore, this multilocular disk with 5–7 loculi, set at the bottom of a short tube, fairly numerous, but scattered, over the whole anterior portion of the body, less numerous on the chitinized apical disk, wanting in the immediate vicinity of the anal ring, present both dorsally and ventrally.

Intermediate stage female.—Not known.

Larva.—(The Maskell slides of this stage show the larva of *C. spiniferus*, not of *casuarinae*, but this fact modifies the description given by him only in regard to the body spines.) Oval, somewhat narrowed behind, antennae 5-segmented, not with six; legs normal; mentum apparently 1-segmented; body, at least in the abdominal region, with five rows of large spines on each side, two dorsal, one marginal, and two ventral, the spines in the latter smaller, all stout and long, but pointed at apex; the spines in *spiniferus* considerably longer than in true *casuarinae*, flattened and incised at apices, not pointed; anal lobes well developed, each with a stout apical spine and a long apical seta, also bearing two smaller spines; anal ring apparently simple, with a chitinized flange above, beneath this two widely separated short spines, and at the bottom two more short spines set close to each other; spines of head reduced to small, relatively slender setae.

Three species besides the type have been placed in this genus. The writers have no information at present in regard to *C. gracilis* Fuller. As noted by Maskell when describing it, *C. amplior* Maskell is very difficult to separate from *C. casuarinae*. *C. spiniferus* Maskell shows some conspicuous differences from the type and is possibly not congeneric with it. In the adult of this species the body, legs, antennae, spiracles, and derm pores appear to be of the same general character

as those found in *casuarinae.* The derm bears stout spines as well as slender setae; the posterior apex of the body is more chitinized and bears in the middle of its disk a pair of heavily chitinized plates, these together forming nearly a circle, and fused along their inner edges with the outer margins of each bearing 4–5 large stout spines; these plates obscuring the anal ring so that its structure can not be determined definitely, but apparently it is entirely without setae. In the larva only the differences in the body spines have been noted.

In the following generic diagnosis an attempt has been made to include both species discussed above within the limits indicated.

GENERIC DIAGNOSIS OF CYLINDROCOCCUS.

Coccids forming woody galls, possibly Eriococcine, adult female with cylindrical body, membranous derm with posterior apex more heavily chitinized in form of a more or less circular disk; antennae short-conical, indistinctly segmented, legs abnormal, much reduced or represented by evaginated pouches; spiracles without multilocular disk pores; mentum 1-segmented; anal lobes wanting, position indicated by grouped spines and setae or fan-shaped spined plates; anal ring simple, setae much reduced in number or wanting; body with setae or spines and setae, the setae long, rather stout, much more abundant at apex of abdomen; with only one type of derm pore, these multilocular, usually quinquelocular disk pores, set at bottom of small tube; larva oval, tapering posteriorly, antennae 5-segmented, set close together, legs normal, abdomen with rows of long, stout setae dorsally and ventrally; anal lobes well developed, each with an apical spine and seta; anal ring simple, with some spines or setae set close to it.

The genus was not assigned to any higher coccid group by Maskell when he originally described it, but was placed by Cockerell in the tribe Eriococcini in his Tables for the Determination of the Genera of Coccidae.[9] The writers have no further changes to suggest at present.

Genus SPHAEROCOCCOPSIS Cockerell.

Plate 2, fig. 3.

Genotype.—Sphaerococcus inflatipes Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 85.

This genus was established by Cockerell on the basis of the presence of legs in the adult female, as contrasted with the condition in *Sphaerococcus;* actually the two genera, as represented by the type species, are very remotely related, if at all. Only the single type species, with its variety, was known when the genus was established, and none have been added subsequently.

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[9] Can. Ent., vol. 31, 1899, p. 277.

The Maskell collection contains two slides of this species, both of "adult female, 1892," and a strip of bark bearing a number of the tests of the insect. From the latter it has been possible to obtain mounts of the adult, cast skins believed to be of the second stage female, and very young larvae, and the following description has been prepared principally from these mounts. The unmounted material bears No. 294.

Before proceeding further it may be well to note that the previous generic characterization is fundamentally wrong, in that the type species possesses a well developed anal ring bearing six large and a few smaller setae.

Adult female.—Test and body about as figured and described by Maskell; antennae reduced, of 6 segments; with three pairs of legs, the two anterior pairs reduced, about half the size of the posterior pair, and appearing more or less deformed; all legs with few setae, the tarsal claws short, the digitules apparently normal, slender, knobbed, but usually injured, posterior tibia and tarsus nearly as thick as femur; mentum apparently 1-segmented, no second segment observed, short and broad conical; spiracles not unusual; without anal lobes, these replaced by a group of large heavy spines, fringing the dorsal area and standing above the anal ring, there being four such spines close together in the middle, then a large seta on each side, then about four more large spines; the region around the anal ring and between it and the spines with numerous slender setae, mostly small, but varying in length; anal ring medium in size, circular, and very stout, set at the inner end of a short tube, with about 10 setae, of which six are larger than the remainder, the ring itself with pores only in circles around the bases of these setae; no traces of eyespots observed; dorsum with a flattened circular area, bordered by stout spines, in a single row continuous with those above the anal ring posteriorly, but considerably smaller and several deep laterally and anteriorly, and also scattered over the dorsal area anteriorly, this area crowded with "cells" of unknown function, but possibly glandular, these circular to irregularly oval in shape, very close together in the center, somewhat more scattered around the margin, mostly appearing as small tubercles or hemispherical nodules, which are continued onto the sides in less completely developed form; only one type of definitely developed gland pore noted, these quinquelocular disk pores, occurring in transverse bands ventrally; body with the stout spines already mentioned, these of two sorts, acutely tapering and pointed on the posterior portion of the body and much more bluntly pointed on the anterior portion; in addition with only slender, hairlike setae, varying considerably in size, a few scattered through the circular dorsal area, others occurring rather thickly ventrally, particularly in the abdominal region.

Intermediate stage female.—A cast skin, possibly of this stage but more probably of the larva, shown in the figure.

Larva.—Oval, tapering somewhat behind; antennae 5-segmented, legs normal but rather stout except the claw, this long and slender; with a marginal row of spines around the body, supplemented on the abdomen by a submarginal row of smaller spines and a median paired row on thorax and a second submarginal row on abdomen; dorsum of anterior part of body with numerous hemispherical tubercles, these continued onto the abdomen in a median paired row and

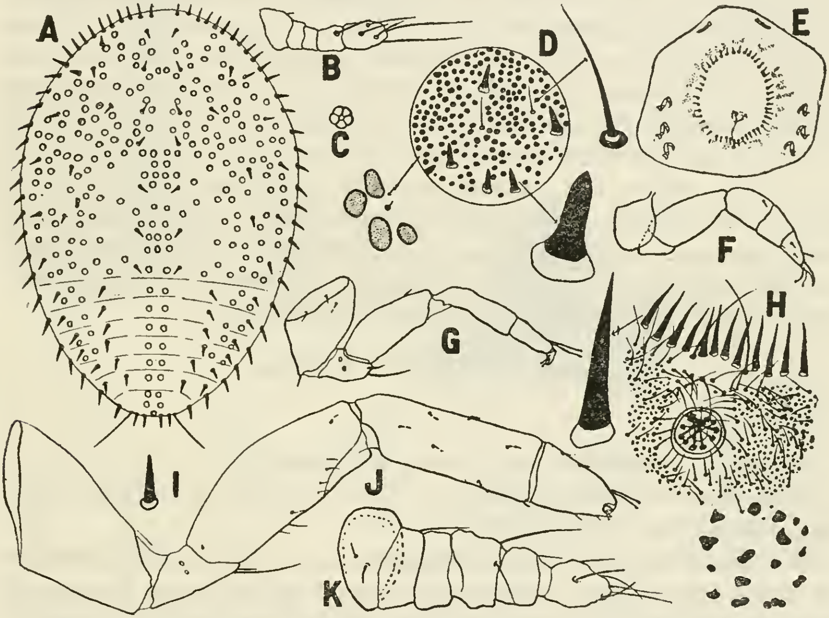

FIG. 9.—SPHAEROCOCCOPSIS INFLATIPES (MASKELL). A. LARVA, OUTLINE FROM ABOVE, ×230; B. LARVA, ANTENNA, ×335; C. ADULT FEMALE, QUINQUELOCULAR PORE, ×640; D. ADULT FEMALE, PORTION OF ANTERIOR DORSAL DERM SHOWING SPINES, SETAE AND "PORES," ×165; E. CAST SKIN OF, POSSIBLY, SECOND STAGE FEMALE, BUT PROBABLY LARVA, ×57.5; F. LARVA, MIDDLE LEG, ×335; G. ADULT FEMALE, FORE LEG, ×115; H. ADULT FEMALE, ANAL RING AREA, WITH FRINGE OF SPINES ABOVE IT, ×115, WITH DETAIL OF SPINE AND OF DERM, ×335; I. LARVA, MARGINAL SPINE, ×640; J. ADULT FEMALE, HIND LEG, ×115; K. SAME, ANTENNA, ×220.

two submarginal rows on each side; anal ring small, circular, apparently with pores, but no setae observed.

Cotype.—Cat. No. 24758, U. S. N. M.

After an examination of Maskell's slides of the variety described by him the writers are of the opinion that it is clearly a distinct species, the differences pointed out by Maskell in his description as well as a number of others being quite pronounced. The generic diagnosis which follows has been modified to include this species as well.

GENERIC DIAGNOSIS OF SPHAEROCOCCOPSIS.

"Dactylopiine" coccids of the Fernald Catalogue, of uncertain location, possibly Eriococcine, but evidently not closely related to the Pseudococcus group of genera; adult female secreting a firm, compact, waxy test, almost horny externally, with spongy inner layer and with circular median dorsal opening, the test more or less sunken in a depression in the bark of the host; adult female circular, like a flattened globule, with a circular to oval dorsal chitinized area; antennae more or less reduced; all legs present, more or less abnormal, the posterior pair much larger than the others; mentum 1-segmented. anal lobes wanting, represented by a pair of long setae and a fringe of large tapering spines above the anal opening; anal ring stout and circular, with setae, and with or without pores, these when present in circles around the setae of the ring; body with dorsal area bearing numerous hemispherical nodules and surrounded by a circle of spines, also with numerous slender setae ventrally and laterally; only a single type of derm pore present, these quinquelocular disk pores; larva oval, antennae 5-segmented, legs normal but stout, with rows of dorsal and lateral spines and numerous hemispherical nodules dorsally; anal ring circular, without setae, and lobes not developed.

Genus CALLOCOCCUS Ferris.

Plate 2, fig. 4.

Genotype.—*Sphaerococcus pulchellus* Maskell.

References.—Fernald, Cat. Cocc. World, 1903, p. 87.—Ferris, Can. Ent., vol. 50, Oct., 1918, p. 328.

This genus has only recently been established by Ferris to include the single type species. Except for what is believed to be the second stage female, which is described here for the first time, the descriptions of Maskell and Ferris have covered the species rather thoroughly, and the writers have noted only a few apparent discrepancies in these descriptions.

The Maskell collection includes three slides of the type species, one labeled "adult female, 1896," one "adult female, side view, 1896," and one "late 2nd stage female, 1896," and a small amount of unmounted material under No. 504, from which it has been possible to otbain additional mounts of the different stages. It may be noted that if the writers have correctly identified and described the intermediate stage female, then Maskell's "late 2nd. stage ♀" actually represents an early adult form.

Adult female.—Somewhat elongate oval, sac-like; derm transparent except for a longitudinal median, dorsal, perforated, chitinized band, continuing around both apices of the body onto the venter, and

supplemented in the middorsal region by two short additional bands, one on each side of and close to the median and paralleling it; antennae reduced to minute unsegmented tubercles bearing 2–3 short setae; without any traces of legs; mentum apparently 1-segmented; spiracles not unusual; with no traces of spiracular spines; body both dorsally and ventrally with scattered tubular ducts with cup-shaped bases and long slender terminal tubes, these more numerous near the

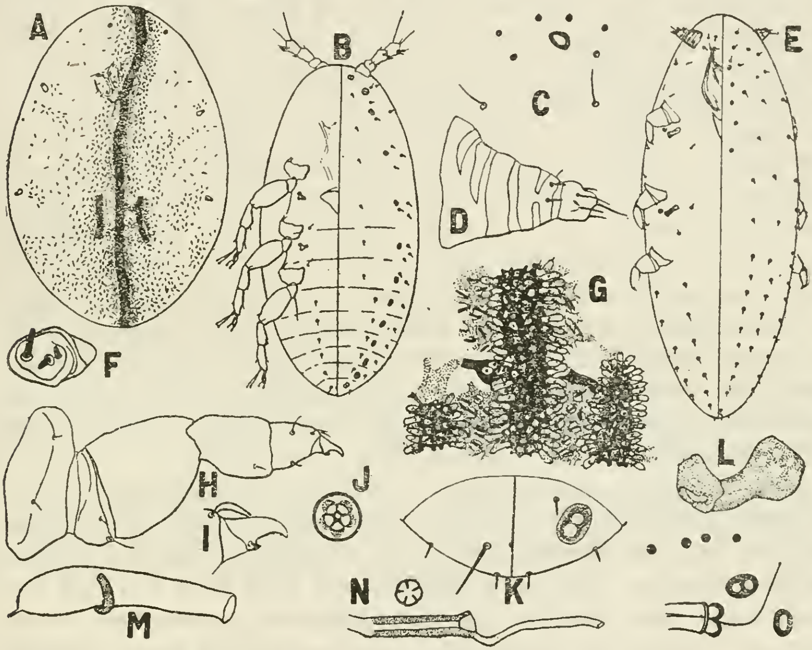

FIG. 10.—CALLOCOCCUS PULCHELLUS (MASKELL). A. ADULT FEMALE, OUTLINE, ×26.5; B. LARVA, OUTLINE, ×115; C. ADULT FEMALE, ANAL RING AND ADJACENT PORES AND SETAE, ×335; D. INTERMEDIATE STAGE FEMALE, ANTENNA, ×335; E. INTERMEDIATE STAGE FEMALE, OUTLINE, ×57.5; F. ADULT FEMALE, ANTENNA FROM ABOVE, ×640; G. ADULT FEMALE, DETAIL OF DORSAL PORE BAND IN ANTERIOR ABDOMINAL REGION, ×115; H. INTERMEDIATE STAGE FEMALE, MIDDLE LEG, ×335; I. SAME, CLAW, ×640; J. ADULT FEMALE, DISK PORE ADJACENT TO SPIRACLE; ×1500; K. LARVA, APEX OF ABDOMEN, ×640; L. ADULT FEMALE, SPIRACLE, ×335; M. ADULT FEMALE, TUBULAR DUCT OF SORT FOUND IN HEAVY BAND, ×1000; N. SAME, TYPE FOUND OVER THE BODY, ×1000; O. ADULT FEMALE, 8-SHAPED PORE FOUND IN HEAVY BAND, TWO VIEWS, ×1500.

median chitinous band; with the 8-shaped pores reduced to an irregular double row running along the center of the chitinized band, and all set at the bottom of short tubercles; with a single row of large tubular ducts, perhaps modifications of the first type mentioned, strongly swollen, with an inverted cup near the middle, and another large swollen portion beyond this terminating in a short cylindrical thread; finally with a few quinquelocular disk pores in the vicinity of each spiracle; derm with only a very few widely separated, tiny,

spine-like setae, these most frequent in the area surrounding the anal ring; anal ring a minute ovate chitinous ring placed beyond the posterior end of the recurved dorsal chitinized band, and so located ventrally.

Intermediate stage female[10] (not of Maskell).—About 1 mm. long, elongate, slender, tapering and rounded at each end, the head more broadly; antennae 5–6-segmented, semirudimentary; broad and stout at base, and tapering strongly to a rounded point, the terminal two segments with some stout spines and setae; legs similarly reduced, stout, claw stout, with two large teeth at base, to which the digitules may possibly attach in perfect specimens, tarsal digitules normal, threadlike, apices slightly knobbed, not extending beyond the apex of the claw; mentum apparently 1-segmented; spiracles not unusual, with a single quinquelocular disk pore immediately adjacent; with a few similar pores dorsally in the thoracic region; derm both dorsally and ventrally thickly set with small knoblike protuberances, these largest dorsally in the anterior portion of the body, progressively decreasing in size to a finely granular condition in the abdominal region; derm with occasional little groups of stout spines each set in a ringlike base on the head, these in more or less distinct rows dorsally and ventrally on the remainder of the body, and somewhat larger posteriorly; anal ring small, simple, located at the posterior end of the body, without traces of anal lobes.

Larva.—Elongate oval, antennae with four stout segments, all bearing setae, and the last two with a short spine on each; legs normal, the claw long and slender, both pairs of digitules long and slender, knobbed at apices, the tarsal attached well back from the apex and much longer than the claw digitules; body with a marginal row of 24 large 8-shaped pores extending clear around the body; spiracles tiny, each bearing one quinquelocular pore; apex of abdomen without traces of anal lobes, but with a pair of relatively large and stout setae, between these the minute, simple anal ring, and above this a smaller pair of setae; each 8-shaped pore with a tiny seta above and below it, in addition with submedian rows of tiny setae both dorsally and ventrally on each half of the body; the median caudal lobe figured by Ferris not discernible in the limited material available for study.

Cotype.—Cat. No. 24759, U.S.N.M.

Both the second stage female and the young larvae were taken from a test which also enclosed an adult female. No species other than the type has been included in this genus, and in view of its peculiarities it is quite probable that it will continue to stand alone.

[10] Subsequent examination of various stages of related species suggests that the writers have possibly been mistaken in considering this as the second stage female, but no definite conclusion has been reached as to the stage it really represents.

The following generic diagnosis has been based on the preceding description.

GENERIC DIAGNOSIS OF CALLOCOCCUS.

Asterolecanine coccids with the adult female enclosed in a striated waxy test of peculiar form; adult female an elongate oval sac with a median dorsal chitinized stripe containing numerous pores and ducts; antennae reduced to tiny disks; legs wanting; mentum 1-segmented; spiracles not unusual; derm with minute 8-shaped pores at bottoms of short ducts, large tubular ducts with swollen inner ends, slender tubular ducts with cup-shaped bottoms and thread-like tube, and quinquelocular disk pores, with only the slender tubular ducts numerous; derm with a few small stout setae and no differentiated anal setae; anal lobes completely wanting, anal ring a minute ovate ring without setae; intermediate stage female elongate, slender, tapering, antennae semirudimentary, 6-segmented, legs reduced, claw digitules if present placed on teeth at base of claw, derm pores reduced to the quinquelocular type only, derm setae much as in adult, anal ring simple, at apex of body; larva elongate oval, with a marginal row of 8-shaped pores and a single quinquelocular pore attached to each spiracle, with small setae dorsally and ventrally in rows, antennae short and stout, 4-segmented, legs normal, digitules normal, anal ring simple, without traces of anal lobes, but with a pair of larger and stouter anal setae.

The writers at present incline to the belief that this genus will find its nearest known relative in the genus *Frenchia*, in spite of the occurrence of a considerable number of divergences.

Genus SPHAEROCOCCUS Maskell.

Genotype.—Sphaerococcus casuarinae Maskell.

References.—Fernald, Cat. Cocc. World, 1903, p. 85.—Ferris, Can. Ent., vol. 51, Nov., 1919, p. 249.

This genus has just recently been redescribed and more correctly located by Ferris (1919), who has also called attention to some errors in Maskell's description. As *S. casuarinae* was the only species included by Maskell at the time he established the genus, it remains the type, and, as noted by Ferris, it is in all probability the only species of all that have been placed in the genus *Sphaerococcus* that can legitimately remain under that name.

The Maskell collection contains five slides of this species, all dated 1891, one of larva, two of second stage female, and two of adult female. There is also a single gall of *Cylindrococcus casuarinae*, under No. 221, which is supposed to bear a specimen of *S. casuarinae*, but the specimen is no longer present, and probably became detached while the gall was still mounted on a pin.

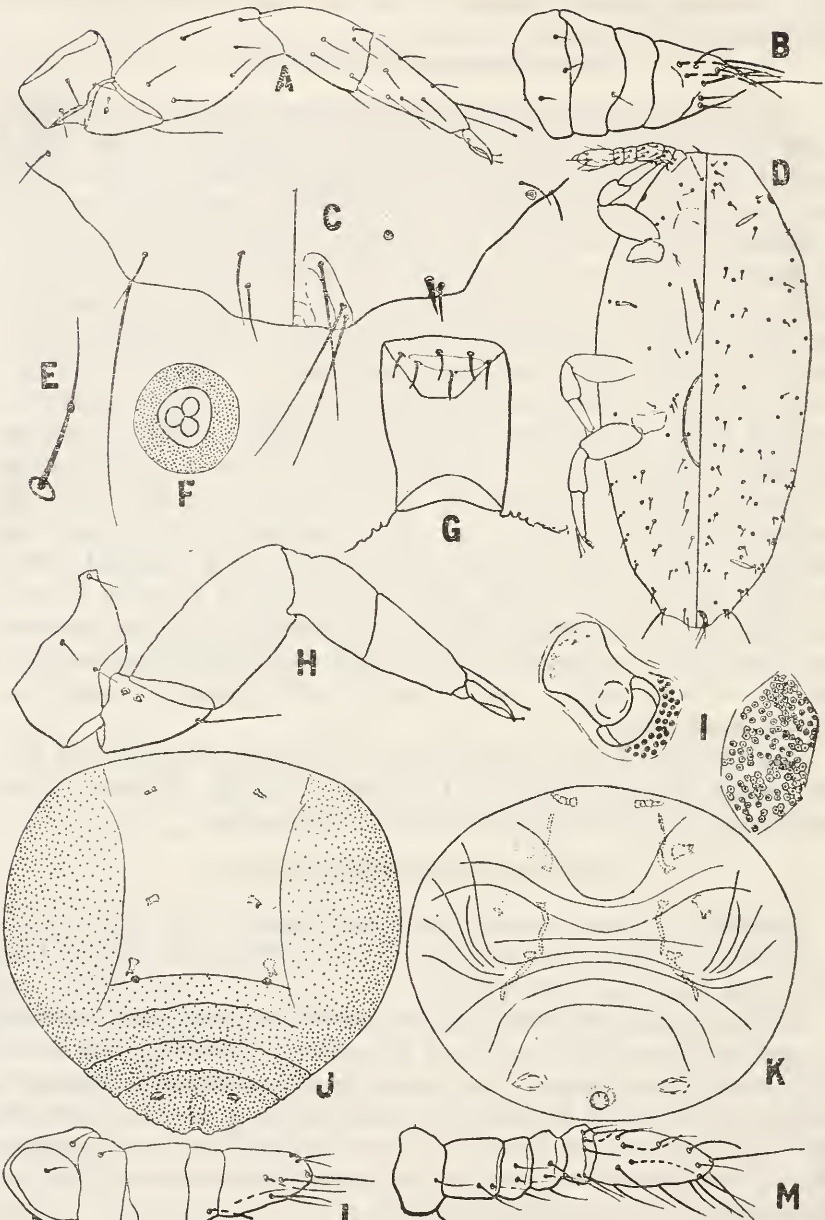

FIG. 11.—SPHAEROCOCCUS CASUARINAE MASKELL. A. LARVA, MIDDLE LEG, ×335; B. ADULT FEMALE, ANTENNA, ×500; C. LARVA, APEX OF ABDOMEN, ×500; D. LARVA, OUTLINE, ×115; E. ADULT FEMALE, DERM SETA, ×1500; F. ADULT FEMALE, DERM PORE, ×1500; G. ADULT FEMALE, ANAL RING, ×165; H. INTERMEDIATE STAGE FEMALE, ANTERIOR LEG, ×440; I. ADULT FEMALE, POSTERIOR SPIRACLE AND ADJACENT PORE PATCH, ×220; J. ADULT FEMALE, OUTLINE, ×30; K. INTERMEDIATE STAGE FEMALE, OUTLINE, ×57.5; L. ANTENNA OF INTERMEDIATE STAGE FEMALE, ×440; M. LARVA, ANTENNA, ×335.

Only the Maskell slide mounts have been available for study, and as these have not proven entirely satisfactory the following descriptions have been confined largely to notes on certain points.

Adult female.—This stage much as described by Maskell, except for the anal ring, this having six short stout setae, as noted by Ferris; the multilocular pores of Maskell's description, so far as can be noted, all trilocular, set at the bottom of short tubes, these appearing rifled as a gun barrel and their openings each surrounded by a circular chitinized plate; disk pores at the spiracular openings also apparently, but not certainly, trilocular; the exact character of the two glandular patches close to the posterior spiracles not determinable, but apparently made up of large simple pores, each surrounded by a chitinized circle and set in a polygonal area; only one type of body seta noted, these rather short and fairly stout.

Intermediate stage, female.—Differing from the adult, as noted by Maskell, in the smaller size, the presence of the legs, and in other particulars; both the tarsal and claw digitules present, not wanting as suggested by Maskell; with six anal ring setae, not two, and the ring set at the inner end of a tube as in the adult; body pores and setae apparently much as in the adult, but without the glandular patches behind the posterior spiracles as in the adult.

Larva.—Quite as described and figured by Maskell and Ferris.

With regard to the species placed in this genus by Maskell, a number have already been removed to other genera, and for the remainder it is possible to confirm the suggestion made by Ferris in discussing this genus, to the extent that none of the Maskell species now referred to the genus are congeneric with the type species, although such peculiar and diverse forms are included under this name that it is impossible to reassign them without extended study.

The following generic diagnosis is given for the sake of completeness in this paper.

GENERIC DIAGNOSIS OF SPHAEROCOCCUS.

Pseudococcine forms having dorsal ostioles, adult female globular, naked, antennae rudimentary, legs wanting, posterior spiracles accompanied by a large poriferous tract, anal ring set at the inner end of an invaginated tube, with pores and six setae, anal lobes wanting, derm with only one type of seta, and with only trilocular pores; intermediate stage, female, similar to adult, but smaller, lacking the poriferous patches and with the legs present and the antennae more developed; larva long oval, with 6-segmented antennae, normal legs, anal ring with pores and six setae, anal lobes slightly produced, with one pair of cerarian spines, one slender, and a long apical seta on each, and with some longitudinal rows of trilocular pores and slender setae.

As is noted by Ferris, this genus is separable from *Antonina* Signoret (as represented by the American and some other species) only by the retention of the legs in the stage preceding the adult, and by having the derm pores of the trilocular type only, all the species of *Antonina* available for examination (six in all) having large multilocular disk pores in addition to the triloculars.

Genus EREMOCOCCUS Ferris.

Plate 2, fig. 5.

Genotype.—*Sphaerococcus pirogallis* Maskell.

References.—Fernald, Cat. Cocc. World, 1903, p. 87.—Ferris, Can. Ent., vol. 51, 1919, p. 252.

This is another genus recently described by Ferris, and so characterized that but little needs to be added to the previous descriptions. It has been possible to make certain corrections and additions, notably with respect to the curious invaginated character of the antennae in the adult female. Only the type species has been placed in this genus thus far.

The Maskell collection contains six slides of this species, one labeled "2nd stage female, 1893," two labeled "adult female, 1893," and three labeled "adult male, 1894," and a lot of material under Maskell No. 364, including a numerous cluster of the galls of the species. The following descriptive notes have been prepared from this material.

Adult female.—Enclosed in a pear-shaped gall as described by Maskell; body an oval sac, flattened above, with an oval, somewhat chitinized dorsal disk, corresponding to the flattened area, occupying most of the dorsum and presenting a rather nodulose appearance; with a wide band, consisting of numerous scattered, long, slender setae and large 8-shaped pores around the margin of this area, venter apparently without pores; with a few scattered setae anteriorly, and a rather numerous cluster around the vaginal opening; antennae of peculiar structure, the number of segments not exactly determinable, consisting of a short evaginated tubercular collar, and a long invaginated tube passing through the collar and far within, with about 5–6 large, stout setae of varying lengths lying at the bottom and pointing up through the tube toward its opening, the longest fully half the length of the tube; spiracles peculiar only in their lack of the multilocular disk pores that usually accompany these structures; legs entirely lacking; internal framework of mouthparts, as noted by Ferris, large and heavily chitinized; mentum apparently indistinctly 2-segmented; derm pores apparently only of the large 8-shaped type already mentioned, none of the loculi indicated by Ferris in his figure of these pores visible in specimens examined by the writers; derm setae of one type, as already described; anal ring

small, simple, circular, set in a small, circular, more heavily chitinized plate on the dorsal surface close to the posterior end of the body.

Intermediate stage female.—Differs from the adult chiefly in degree, the size smaller, the number of pores and setae very much less, and the antennae only a little invaginated, the antennal setae

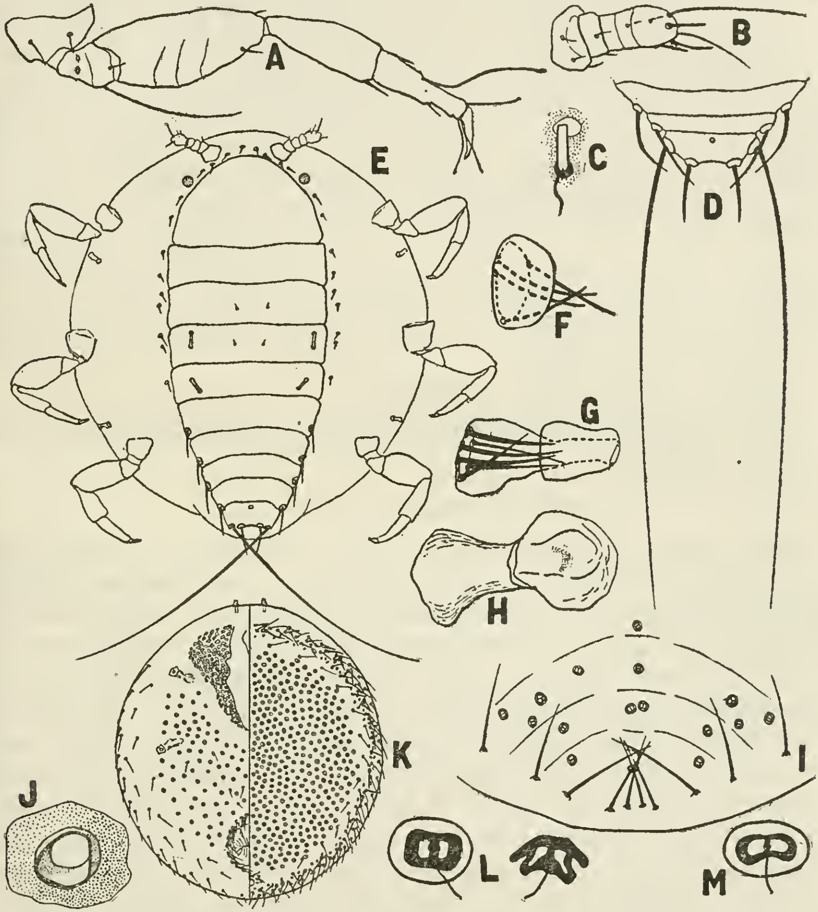

FIG. 12.—EREMOCOCCUS PIROGALLIS (MASKELL). A. LARVA, LEG, ×440; B. LARVA, ANTENNA, ×440; C. LARVA, TUBULAR DUCT, ×640; D. LARVA, APEX OF ABDOMEN, ×440; E. LARVA, OUTLINE, PROBABLY OF CAST SKIN, ×165; F. INTERMEDIATE STAGE FEMALE, ANTENNNA, ×640; G. ADULT FEMALE, ANTENNA, ×640; H. ADULT FEMALE, SPIRACLE, ×335; I. INTERMEDIATE STAGE FEMALE, ANAL RING REGION, ×230; J. ADULT FEMALE, ANAL RING, ×640; K. ADULT FEMALE, OUTLINE OF BODY, ×57.5; L. AND M. 8-SHAPED PORES, DIFFERENT VIEWS, ADULT FEMALE, ×1500.

protruding distinctly from the collar; the long setae near the anal ring in a more or less distinct single row (this not the 2nd stage female of Maskell).

Larva.—(2nd stage of Maskell) (cast skins only) Broad oval, rather pointed at posterior extremity, dorsum more heavily chitinized, forming an elongate oval area marked by distinct transverse seg-

mental divisions; antennae with two distinct basal segments and a long and large third one indistinctly divided into three segments, making a possible total of five segments; body with a few setae along the margin, these very small anteriorly, but much larger, stouter, and with one curved pair to each abdominal segment posteriorly, the apical segment with anal lobes very slightly indicated, and bearing a stout setae inside and a slender, hair-like, much longer one, perhaps two-thirds the body length outside, on each half; dorsally with a pair of small submedian spines on at least the anterior segments; gland pores, so far as can be observed, confined to two pairs, one pore located on the margins of, apparently, the first and second abdominal segments, these long tubular, with slightly swollen bottom, and apparently possessing a median dividing wall in the bottom portion of the tube; legs well developed, moderately heavy, the femora imbricated, the tarsal digitules attached peculiarly, as noted by Maskell; eye spots showing as small, round disks just behind the antennae.

Cotype.—Cat. No. 24760, U.S.N.M.

The following generic diagnosis has been prepared from the preceding description.

GENERIC DIAGNOSIS OF EREMOCOCCUS.

Gall making coccids belonging in the subfamily Dactylopiinae of the Fernald Catalogue; adult female an oval membranous sac, flattened and more heavily chitinized dorsally in a disk; antennae invaginated, segmentation indefinite, legs wanting, internal framework of mouth parts very large and heavy, mentum indistinctly 2-segmented; spiracles normal, not accompanied by disk pores; derm pores of one type only, large, heavy, 8-shaped; derm setae of one type only, stout, tapering; anal ring minute, simple, placed dorsally near posterior apex of body; no traces of anal lobes; intermediate stage female similar to adult, except smaller, body not chitinized dorsally, hairs and pores fewer, with an occasional pore trilobed; antennae less invaginated; larva oval, pointed behind, more chitinized dorsally, antennae distinctly 3-segmented, perhaps 5-segmented, legs well developed, one tarsal digitule placed about midway between the base and apex of tarsus, derm pores reduced to two pairs of long, heavy tubular ducts located on basal abdominal segments, body margin with setae, these stouter posteriorly, apex of abdomen without distinct anal lobes, but with one long slender seta; anal ring minute, simple.

The writers are not able to place this genus any more definitely than did the describer. The heavy 8-shaped pores suggest a possible connection with the Asterolecaninae, but there seems to be little else to bear this out.

Genus EPICOCCUS Cockerell.

Plate 3, fig. 1.

Genotype.—Coccus acaciae Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, pp. 88, 89.

This genus as established by Professor Cockerell included only the type species, and none have been added to it subsequently.

There is a small number of unmounted specimens with the Maskell No. 505, one slide labeled "adult female, 1896," one "antenna and feet of female, 1896," and one "larva, 1896," under this name in the Maskell collection. It has been possible to obtain an additional mount of an adult female and a larva from the unmounted material, and these have proven to be of considerable assistance in preparing the following description.

Adult female.—Body, as stated by Maskell, dark red, usually much wrinkled, more or less globular or somewhat conical above, naked except for some ventral secretion, resembling some *Antonina* species in this respect; fully mature form, when boiled in potassium hydroxide expanding to an almost spherical sac, with the ventral surface slightly flattened; antennae small, 6-segmented, typically Pseudococcine in appearance; legs small but otherwise normal, claw without denticle, digitules normal, slender, knobbed, hind coxae with numerous pores; mouthparts small, mentum apparently 2-segmented; dorsal ostioles obscure; with only the two posterior pairs of cerarii present as such, the remainder of the margin of the ventral surface with a continuous band of trilocular pores and short, slender, tapering but blunt-tipped spines, together with an occasional slender seta, the cerarian spines slender, acute at apices, somewhat lanceolate, and considerably larger than those of the band; spines of band clustered more or less, although very indistinctly, into small groups with only pores intervening; anal lobe cerarii set on small protuberances, each accompanied by a slight chitinized area and each composed of from 10–15 lanceolate spines, accompanied by a somewhat larger number of small triangular pores; with a relatively large and stout apical seta below, but this shorter and more slender than the anal ring setae; without ventral chitinized thickenings; anal ring small, with pores in an inner and an outer row on each half, with six relatively large, stout setae, placed dorsally quite a distance from the apical cerarii, as compared with other Pseudococcine forms, and at the inner end of a short delicate membranous tube which is much longer below than above: with the two long setae usually occurring below the anal ring in *Pseudococcus* and related forms placed directly between the two apical cerarii and at a distance from the ring; derm, so far as noted, with three types of pores, the usual trilocular. triangular pores, occuring in the cerarii, the marginal band and widely

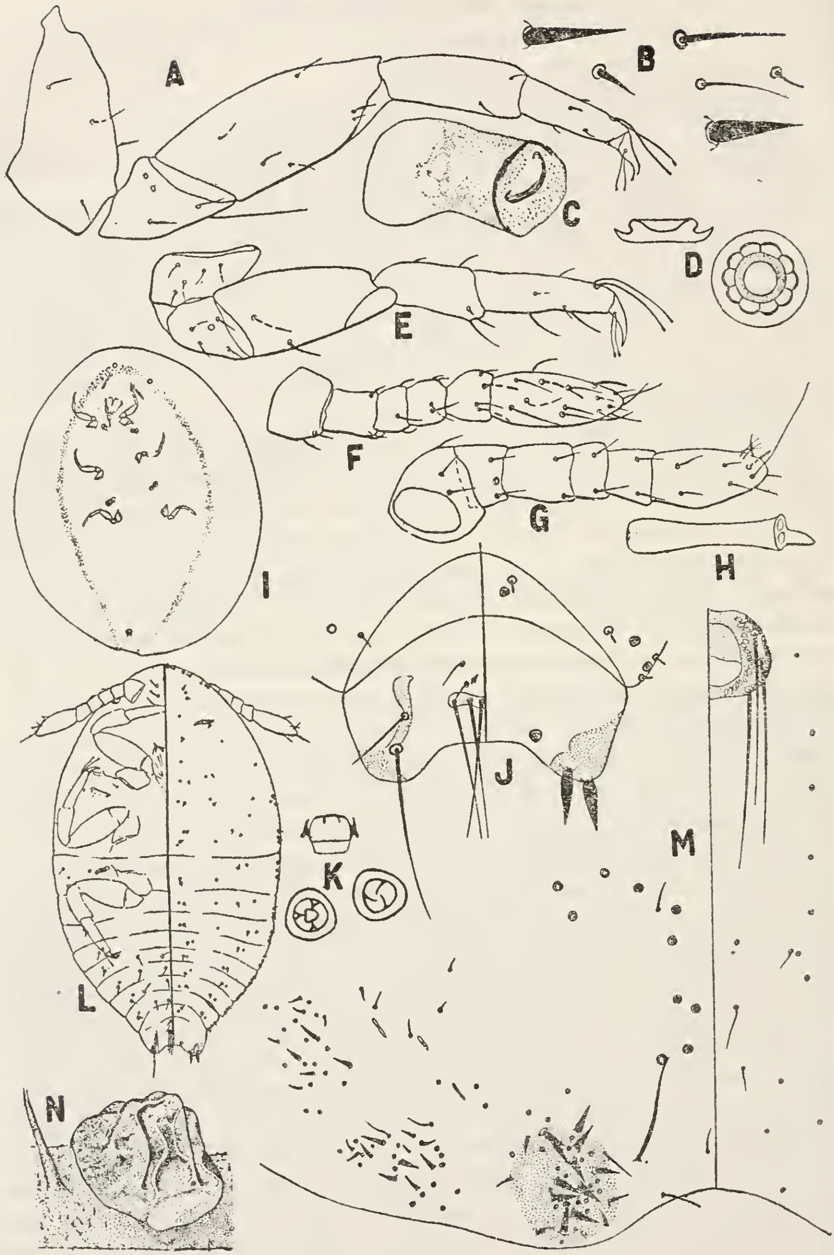

FIG. 13.—EPICOCCUS ACACIAE (MASKELL). A. ADULT FEMALE, MIDDLE LEG, ×115; B. ADULT FEMALE, BODY SPINES, THE LARGEST FROM CERARII, ×500; C. ADULT FEMALE, SPIRACLE, ×115; D. ADULT FEMALE, VENTRAL DISK PORE, TWO VIEWS, ×1500; E. LARVA MIDDLE LEG, ×335; F. LARVA, ANTENNA, ×335; G. ADULT FEMALE, ANTENNA, ×115; H. ADULT FEMALE, TUBULAR DUCT, ×1500; I. ADULT FEMALE, OUTLINE OF BODY FROM BELOW, ×17.5; J. LARVA, APEX OF ABDOMEN, ×440; K. ADULT FEMALE, TRILOCULAR PORE, THREE VIEWS, ×1500; L. LARVA, OUTLINE OF BODY, ×115; M. ADULT FEMALE, APEX OF ABDOMEN SHOWING CERARII, ANAL RING, ETC., ×165; N. HABIT SKETCH, ADULT FEMALE, ×7.5.

scattered over the dorsum, these larger in the anterior portion of the band, the large multilocular disk pores, occurring ventrally in the abdominal region, and the short cylindrical tubular ducts, these occurring rarely in or adjacent to the marginal band; possibly with tiny quinquelocular pores near the spiracle, but the structure of these not determinable with certainty; with large, lanceolate cerarian spines, smaller, more slender, blunt-tipped spines in the marginal band, and scattered widely on the dorsum, slender tapering peglike spines; with slender setae of varying sizes in the marginal band and widely scattered on the body.

Intermediate stages.—None available for examination.

Larva.—Oval, slightly pointed behind, abdominal segmentation distinct; antennae 6-segmented, the last much the longest; legs normal, claw simple, digitules normal; mentum indistinctly 2-segmented; anterior dorsal ostioles set back well behind the anterior border of the framework of the mouthparts, posterior between the fifth and sixth (visible) abdominal segments; anal lobes somewhat produced, short triangular, more heavily chitinized than the derm, chitinization continued anteriorly beneath as a narrow strip bearing the ventral setae, with a pair of large lanceolate spines above, one apical, the other just before it, and a long slender, subapical ventral seta and a shorter basal one; anal ring overlapped above by the dorsal derm, open beneath, set in rather deeply between the anal lobes, cellular and with six long setae, the longest extending beyond the apex of the anal lobes; with two pairs of slender setae, the upper about twice the length of the lower, just beneath the anal ring; upper surface with trilocular pores and slender, peg-like spines, these mostly paired together and on the abdomen in three longitudinal rows on each half of the body, the outer row marginal, the inner submedian, ventral surface with a submedian row of slender setae, and three rows of peglike spines, similar to but longer and more slender than the dorsal ones, on each half of the abdomen, the outer row nearly marginal.

Cotype.—Cat. No. 24761, U.S.N.M.

The following generic diagnosis has been prepared from the preceding description.

GENERIC DIAGNOSIS OF EPICOCCUS.

Pseudococcine forms, having dorsal ostioles, triangular pores, cerarii and other structures normal to that group; adult female globular or nearly so, antennae 6-segmented, normal, legs normal, mentum obscurely 2-segmented, only the two posterior pairs true cerarii, rest represented by continuous marginal band of spines and pores, the former somewhat grouped, each cerarius composed of a cluster of lanceolate spines and triangular pores, the apical pair slightly chitinized beneath, no ventral chitinous thickening, anal ring placed dors-

ally, well separated from lobe area, with six setae and two rows of pores, apical seta of lobes smaller than anal ring setae; derm with three distinct pore types, triangular, multilocular disk and cylindrical tubular, and with lanceolate spines (cerarian), slender peg-like spines and slender pointed setae of varying sizes; larva oval, antennae 6-segmented, legs normal, dorsum with triangular pores and slender peg-like spines, anal ring normal, with six setate, anal lobes developed, each with a pair of large lanceolate spines dorsally and a subapical and subbasal seta, only the anal lobes with indications of cerarii.

As will be noted from the preceding description, this species was incorrectly described by Maskell, and consequently very inaccurately placed. Cockerell in creating the genus *Epicoccus* for this species placed it more correctly, stating that it was "Dactylopiid," which presumably meant that he followed his key to the genera of Coccidae in placing it, and so referred to what is called the subfamily Dactylopiinae of the Fernald Catalogue. In this catalogue the genus is placed just before *Phenacoccus*, which locates it still more correctly. The genus is actually a member of the group, probably a subfamily, of which *Pseudococcus* may be looked upon as the typical genus. The writers are not sufficiently familiar with this group of genera to state whether or not this genus is synonymous with any other previously or subsequently described genus, nor to place it with any accuracy in the series, although from present knowledge its affinities appear to lie with *Ripersia* and its relatives.

Genus LACHNODIUS Maskell.

Genotype.—*Dactylopius eucalypti* (Maskell).

Reference.—Fernald, Cat. Cocc. World, 1903, p. 95.

Maskell included three species in this genus, one previously described and two new, at the time he originally established it, and the type does not appear to have been fixed until the publication of the Fernald Catalogue, in which *eucalypti* is indicated as the genotype.

There are six slides of this species in the Maskell collection, one of "adult female, Australia, 1886," one of "adult female, 1893," one of larvae, Australia, 1886," one of "larvae, 1894," one of "adult male, Australia, 1886," one of "antennae and feet of male, Australia, 1886." The 1886 slides are evidently the types of the species. In addition there is a very small amount of material in position on the host, under Maskell No. 206. From this material the following description, supplementary to that given by Maskell, has been prepared.

Adult female.—Body of mounted female nearly circular, antennae 7-segmented, similar to the *Eriococcus* type rather than to the *Pseu-*

dococcus type, the two basal segments each with a long seta; and the apical segment with several fairly long setae; legs not very long, fairly stout, the tibia and tarsus thick, tarsal claw short and stout, without denticle, digitules normal, threadlike, with swollen tips; coxae without pores, but with two long setae at apex below; eyespots

FIG. 14.—LACHNODIUS EUCALYPTI (MASKELL). A. LARVA, ANTENNA, ×440; B. LARVA, APEX OF ABDOMEN, ×440; C. LARVA, OUTLINE OF BODY, ×165; D. ADULT FEMALE, ANTENNA, ×115; E. ADULT FEMALE, ANAL RING, ×220; F. ADULT FEMALE, TYPES OF SPINES, ×1500; G. ADULT FEMALE, TUBULAR DUCT, ×1500; H. ADULT FEMALE, QUINQUELOCULAR PORE, ×1500; I. ADULT FEMALE, LEG, ×115; J. LARVA, LEG, ×440.

not observed; mentum small, short-triangular, 1-segmented, apex rounded; no traces of dorsal ostioles noted; margin of body with a single row of short, sharp conical spines and much longer setae alternating, or more frequently with two spines and then one seta; body elsewhere with occasional short sharp spines, and small blunt spines,

and more numerous slender setae, the latter varying considerably in size; so far as can be noted, with only two types of derm pores, quinquelocular disk and large tubular, the latter opening into a somewhat chitinized circle and with the inner end appearing slightly bilobed from some angles at least; anal lobes completely wanting, no traces of apical spines or setae evident; anal ring set well in from the margin, circular, bearing about 20 setae, mostly large, but some slightly but distinctly smaller, and with pores, these not in continuous rows as in *Pseudococcus* and its relatives, but with a circle of pores around the base of each seta, an arrangement similar to that already described for *Sphaerococcopsis.*

Intermediate stage.—Not known.

Larva.—Small, broad oval, flat, margin of body with a continuous series of flat, pointed flabellate spines, these shorter and broader anteriorly, longer and more slender posteriorly, the continuous row interrupted only a little on each side of the head at the eyespots; with a total of 31–32 pairs of these around the body, the three posterior pairs smaller and very frequently broken off more or less at the apices; antennae 6-segmented, cylindrical, the apical segment longest, with a seta at apex about as long as the whole antenna and with the three apical segments each with one or more slender curved spines; legs rather stout, the tibia noticeably shorter than the tarsus, the digitules slender with a slight knob at apex, the tarsal about twice the length of the claw, claw without denticle; mentum small, short triangular, apparently 1-segmented; dorsal ostioles wanting, anal lobes not developed, the apex of the body with only an incision for the anal ring; lobes indicated by the presence of a long slender seta on each side of the ring, between the second and third flabellate spine; anal ring small, vertical, so far as can be observed with six setae, of which the lower two are distinctly larger than the others, the presence or absence of pores in ring not determinable; body apparently without derm pores; dorsally with a submedian row of slender setae each set in a large ring base, with an additional pair of these on each side of the thorax; ventrally with a submarginal row of minute spines, one to a segment, and on the posterior abdominal segments with an inner similar row.

Cotype.—Cat. No. 24762, U.S.N.M.

All of the three species described by Maskell as members of this genus can probably be properly retained in it. It is doubtful if any of the others subsequently placed here are properly assigned, since it seems apparent that later writers have confused certain Pesudococcine forms with this genus on account of the numerous anal ring setae. The writers can not relocate these species definitely, but suggest the possibility that the genus *Lachnodiella* Hempel (origi-

nally proposed without description by von Ihering) will fit them more correctly than any other described genus. The larvae of Maskell's three species can easily be separated, as those of both *lectularius* and *hirtus* have conical marginal spines, instead of the swollen ones found in *eucalypti*, while the *lectularius* larva is even broader oval than *eucalypti*, and that of *hirtus* is much more slender, and tapers strongly behind, and as compared with *lectularius*, bears numerous body setae. The adults may also be readily differentiated, that of *lectularius* having a closely set continuous marginal row of long conical, slender tipped, and rather delicate spines, while, as stated, *eucalypti* has short, stout conical spines, alternating with slender setae, and *hirtus* has undifferentiated marginal spines, and the whole dorsum with numerous but scattered slender, long, and rather delicate spines. The differences in *hirtus*, both in larva and adult, are such that it may prove desirable to remove it to a distinct genus after it has been studied more thoroughly.

An effort has been made to cover the three Maskell species in the following generic diagnosis:

GENERIC DIAGNOSIS OF LACHNODIUS.

"Dactylopiine" coccids, occurring free or protected by the bark of the host, naked or more or less covered by secretion; adult female circular, flattened, antennae normally 7-segmented, tending to be long and slender, the terminal segment smallest, legs rather stout, the tibia much longer than the tarsus; mentum 1-segmented; dorsal ostioles wanting, derm with two types of pores, quinquelocular disk and large tubular opening into chitinized ring (based on *eucalypti* only); derm with spines and slender setae more or less definitely arranged along the margin and dorsally, anal lobes wanting, no anal cleft, no cerarii, anal ring dorsal, some distance from margin, circular, complete, bearing numerous (about 20) setae of varying lengths, each of these with a circle of pores around its base; intermediate stages of female not known; larva elongate to very broad oval, margin with an almost continuous series of stout spines, lanceolate or conical, with a single pair of apical setae, antennae 6-segmented, the apical largest; legs normal, mentum 1-segmented, no dorsal ostioles, anal lobes not developed, derm pores wanting, body setae, except marginal, small, slender, more or less numerous, anal ring with six setae.

The writers are unfortunately able to offer no definite suggestions as to the proper position of this genus within the "subfamily" Dactylopiinae. Its possible connection with *Sphaerococcopsis* has already been indicated in the specific description. It does seem

obvious that it is not closely related to the *Pseudococcus* group of genera as has been believed by authors subsequent to Maskell.

Genus ERIUM Cockerell.

Genotype.—*Dactylopius globosus* Maskell.

References.—Fernald, Cat. Cocc. World, 1903, p. 112.—Morrison, Proc. Ent. Soc. Wash., vol. 21, 1919, p. 74.

The confusion which already exists in regard to this genus has been still further complicated by the discovery, as will be evident from the following description, that a serious error has been made as to the species that is really the type of the genus. From the context of Maskell's comments on the species *D. globosus* following his description, it is evident that he regarded the material received from Crawford some years before the publication of the description as the true type specimens of the species. A careful examination of Maskell's slides and material shows plainly that the specimens he mentions as having come from Mr. French are a different species from those received from Crawford, and that it is specimens of Mr. French's species which Maskell has sent out to other coccidologists, thus giving to other entomologists an incorrect conception of the genus. The group of species placed under *Erium* in the Fernald Catalogue will therefore, if they represent a valid generic group, require a new genus name, while *E. globosum* of authors (Maskell in part only) will need a new specific name. The writers therefore propose the name *Amonostherium*, new genus, for the group of species formerly included under *Erium*, propose the specific name *confusum*, new species, for the species *globosum* of authors and Maskell in part, and designate the common American species *lichtensioides* (Cockerell) as the type of this new genus, but for the present do not attempt to indicate definitely the disposition of all the species formerly placed under *Erium*.

This species is represented in the Maskell collection by a single slide labeled "adult female, Australia, 1886." There is also another, labeled "adult female, 1891," representing *Amonostherium confusum*. There is also some unmounted material, divided into three lots, under No. 82, one of which represents true *Erium globosum*, while the other two are the previously unnamed species. The following descriptions and figures have been taken from Maskell's true type material.

Adult female.—Oval, stout, strongly convex, enclosed in a fluffy white sac; antennae 7-segmented, rather stout and short, the terminal segment longest; legs short and stout, otherwise normal, the digitules knobbed, the claw pair stouter; every part of hind legs except tarsus with numerous small clear pores, not definitely grouped; mentum rather long triangular, distinctly 2-segmental;

spiracles large, normal; cerarii probably numerous, but those anterior to the last four pairs represented only by a pair of slender setae so widely separated that they can not be definitely characterized as cerarii, posterior cerarius with two fairly stout, conical

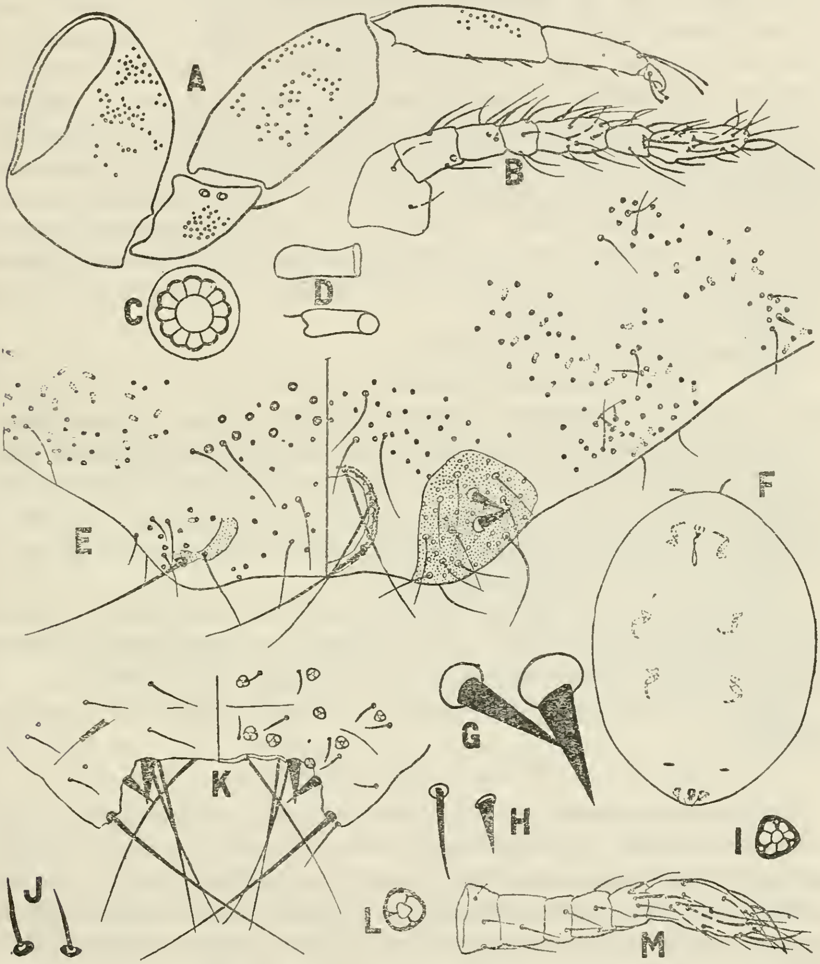

FIG. 15.—ERIUM GLOBOSUM (MASKELL). A. ADULT FEMALE, HIND LEG, ×165; B. SAME, ANTENNA, ×165; C. SAME, VENTRAL DISK PORE, ×1500 D. SAME, TUBULAR DUCTS, ×1500; E. SAME, APEX OF ABDOMEN, ×165; F. SAME, OUTLINE OF BODY, ×12; G. SAME, POSTERIOR CERARIAN SPINES, ×500; H. SAME, PAIR OF CERARIAN SPINES THIRD FROM POSTERIOR APEX, ×500; I. TRIANGULAR PORE, ADULT FEMALE, ×1500; J. LARVA, SETAE, ×1500; K. LARVA, APEX OF ABDOMEN, ×500; L. LARVA, TRIANGULAR PORE, ×1500; M. LARVA, ANTENNA, ×335.

spines accompanied by a group of about 8–10 slender setae and a widely scattered cluster of triangular pores; penultimate cerarius with two considerably smaller spines, about three setae and only a few pores; antepenultimate cerarius with two spines, one more

slender than the other, as long as but more slender than those of penultimate cerarius, two setae and a few pores; fourth cerarius similar to third; remainder of cerarii, so far as can be determined, represented only by slender, almost hairlike setae, possibly occurring in pairs, but the members of such pairs widely separated; anal lobes obsolete, their location indicated by an apical seta about as long as the anal ring setae, by a chitinized thickening of slight density surrounding the apical cerarius, and by a small, narrow, diagonal ventral thickening; derm dorsally with an occasional triangular pore, still less frequently with a long, slender, hairlike seta, and still more rarely with small tubular ducts; anal ring compound, with a double row of pores and six rather large setae; posterior dorsal ostioles distinct; ventral surface in abdominal region with rather numerous circular multilocular disk pores and hairs arranged in transverse rows.

Intermediate stage—not known.

Larva—(from embryonic specimens within body of adult only) oval, antennae 6-segmented, terminal largest; legs not determinable; with a pair of somewhat developed anal lobes bearing an apical seta, and on the inner face, the only pair of cerarian spines that are plainly developed, these relatively large, conical; anal ring with six setae, dorsum with triangular pores and setae, venter with slender setae.

Cotype.—Cat. No. 24763, U.S.N.M.

The status of the species formerly included in the genus *Erium* has already been discussed. It is sufficient to repeat here that none of them appears congeneric with the true type of the genus.

The following generic diagnosis is based on the preceding description.

GENERIC DIAGNOSIS OF ERIUM.

Pseudococcine forms, having dorsal ostioles and triangular pores; adult female oval, approaching globular, enclosed in a fluffy sac, antennae 7-segmented, normal, legs normal, claw without denticle, definite cerarii reduced to not more than four pairs, cerarian spines conical, posterior pair underlaid by thickening, with slight ventral thickening, apical seta about as long as those of anal ring, derm with setae, but no spines, derm with triangular pores, multilocular disk pores, and short tubular ducts; anal ring compound, with two rows of pores and six setae; larva oval, antennae 6-segmented, derm with setae and triangular pores, with only the apical pair of cerarian spines developed, anal ring with six setae.

This genus, as based on the type species, appears to offer no distinct characters to separate it from the genus *Trionymus* Berg, as the latter has recently been emended by Ferris,[11] although it certainly

[11] Calif., Species Mealy Bugs, 1918, pp. 35, 66.

differs prominently in shape from the type of that genus, *T. perrisi* (Signoret). The writers incline to place *Erium* as a synonym of *Trionymus*, but leave a definite statement of transfer to some time when the group can be studied as a whole.

Genus PSEUDORIPERSIA Cockerell.

Plate 3, fig. 2.

Genotype.—*Eriococcus turgipes* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 115.

This was first established as a subgenus, with only the type species included, and while later raised to generic standing, no other species have been added to it.

The Maskell collection contains five slides of the type, one of "adult female, dorsal view, 1892," one of "adult female, ventral view, 1892," one of "anal ring, 1892," one of "larvae, 1892," and one of "larva, 1896." There is also some unmounted material bearing the Maskell No. 267.

Adult female.—Enclosed in a sac, body subglobular, slightly flattened dorsally, etc., as described by Maskell in detail; dorsal surface more heavily chitinized, somewhat brownish, head and thoracic regions very large, occupying fully three-fourths of the whole body and bringing the posterior legs far back; antennae small and inconspicuous, 6-segmented, the third and last segments about equal in length; legs relatively very large, short and stout, so arranged as to give the appearance of six equidistant stout spikes projecting from the circular body, the parts fused so that only two distinct segments and a claw are visible, the outer segment with a cluster of tiny spines beneath at the apex, this segment in the hind legs also with a cluster of numerous tiny circular pores above, claw of peculiar shape, probably comprising both tarsus and claw, claw digitules tiny acute hairs; mentum long, tapering, but with apex rounded, distinctly 2-segmented; only the posterior cerarii isolated, each surrounded by a heavily chitinized half-oval plate, extending down and beyond the apical seta, the cerarius made up of a cluster of lanceolate or sublanceolate spines and triangular pores in about equal numbers; apical seta shorter than anal ring setae; with the penultimate cerarius beginning an almost continuous marginal row of triangular pores, accompanied by more scattered and fewer lanceolate spines of varying sizes, this row wandering irregularly around the whole body margin from cerarius to cerarius, and paralleled by a less conspicuous and less well-developed inner band, the pores in the bands set off from the numerous similar surrounding pores by their larger size and closer grouping, the spines accompanying this band becoming fewer and more scattered anteriorly; dorsally, in addition to the

pores and spines already mentioned, with numerous lanceolate spines of various sizes, these in transverse rows on the abdominal segments

FIG. 16.—PSEUDORIPERSIA TURGIPES (MASKELL). A. LARVA, APEX OF ABDOMEN, ×335; B. ADULT FEMALE, TRIANGULAR PORE, ×1500; C. ADULT FEMALE, MULTILOCULAR DISK PORE, ×1500; D. LARVA, OUTLINE OF BODY, ×115; E. LARVA, TRIANGULAR PORE, ×1500; F. ADULT FEMALE, APEX OF ABDOMEN, ×165; G. LARVA, MIDDLE LEG, ×230; H. LARVA, ANTENNA, ×230; I. ADULT FEMALE, POSTERIOR LEG, ×165; J. ADULT FEMALE, ANTENNA, ×165; K. ADULT FEMALE, CERARIAN AND BODY SPINES, ×500; L. PORE, ADULT FEMALE, ×1500; M. ADULT FEMALE, TUBULAR DUCT, ×1500.

just anterior to the anal ring, but scattered elsewhere, and with many small tubular ducts and triangular pores; ventrally with numerous

long, slender setae, larger tubular ducts and, near the anal ring, a few multilocular disk pores.

Intermediate stages.—Not known.

Larva.—Rather elongate oval, antennae large, 6-segmented, terminal segment much the largest and tapering to an acute point; legs normal, rather slender, tarsus longer than tibia, digitules all long, slender, slightly knobbed, one of tarsus placed basad of the other, claws with a tiny denticle near the apex; mentum 2-segmented, tapering, apex almost conical and with a number of long setae; anal lobes slightly developed, each with a chitinized area dorsally, this bearing a single triangular pore placed between a pair of lanceolate spines, ventrally and subapically with a long, stout seta, slightly longer than the anal ring seta; body ventrally with two tiny, circular submarginal rings on each segment and six longitudinal rows of slender setae; dorsally with three more or less complete rows of slender spines with similar but stouter spines along the margin, and with five more or less complete rows of triangular pores; with two pairs of dorsal ostioles, both distinct; anal ring circular, with six setae and some pores.

Cotype.—Cat. No. 24764, U.S.N.M.

The following generic diagnosis has been drawn from the preceding description.

GENERIC DIAGNOSIS OF PSEUDORIPERSIA.

Pseudococcine forms having the adult female enclosed in a thin, tough, globular sac attached to the twigs of the host; adult female globular, somewhat flattened; dorsum and sides, except posterior apex, more heavily chitinized, antennae small and short, 6-segmented; legs large, very stout and short, the posterior pair attached very far back, the three pairs radiating from the circular body at about equal distances from each other, segments fused so that only two segments and a claw remain; mentum 2-segmented; with at least the posterior dorsal ostioles present, with the posterior cerarii only developed, placed on a half oval chitinized area, remainder of cerarii represented by a continuous row of pores and lanceolate spines, accompanied by a less distinct inner row, cerarii made up of lanceolate spines and triangular pores, but no setae; dorsal derm with lanceolate spines, triangular pores and tubular ducts, ventral derm with long slender setae and multilocular disk pores; anal ring large, circular, with six setae and numerous pores of two sorts; larva elongate oval, antennae 6-segmented, legs normal, mentum 2-segmented, dorsal ostioles present, anal cerarius developed, with chitinized area, two spines and a triangular pore, body with row of setae and triangular pores, anal ring with six setae.

In the remarkable structure of the body and the legs, this genus seems to possess characters which make it stand alone among the Pseudococcine forms, and to fully justify its isolation as a distinct genus.

Genus RIPERSIELLA Tinsley.

Genotype.—Ripersia rumicis Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 115.

This genus name was first published by Professor Cockerell, with a sufficient indication of Tinsley's authorship, and included two species, but the type was subsequently designated by Professor Cockerell as Maskell's species.

This species is represented in the Maskell collection by two slides, one of "adult female, 1890," the other of "head and abdomen of

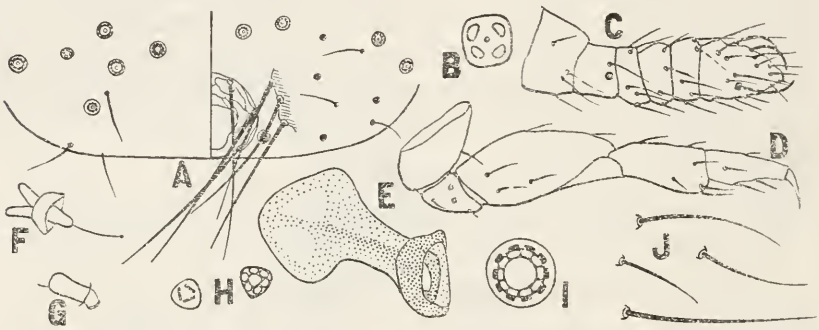

Fig. 17.—Ripersiella rumicis (Maskell); all figures of adult female. A. Apex of abdomen, ×335; B. quadrilocular pore, (probably a freak), ×1500; C. antenna, ×335; D. middle leg, ×335; E. spiracle, ×1500; F. double tubular duct (probably a freak), ×1500; G. tubular duct, ×1500; H. triangular pore, two views, ×1500; I. normal multilocular disk pore, ×1500; J. body setae, ×1500.

adult female, 1890," and by a few unmounted specimens under No. 170.

Adult female.—Practically naked, elongate oval when mounted; antennae short and stout, placed very close together at the anterior apex of the head, 6-segmented, the first and last longest, the last with three stout spines; legs small. stout, the tibia and tarsus about equal in length, claw long, slender, only slightly curved near apex, without denticle, claw digitules slender, apparently acute at apices, tarsal digitules not observed, hind coxae without pores; mentum rather long triangular, indistinctly 2-segmented; spiracles small, not abnormal; with four pairs of dorsal ostioles; anal ring small, stout, with six well-developed setae, without pores of the type found in the ring of *Pseudococcus*, for example, but with some relatively large, faint, uneven areolation; cerarii wholly wanting, the anal lobes not developed, their location indicated by a group of three setae about as long as those of the anal ring and placed on each side of this;

body elsewhere with scattered setae of varying lengths, both dorsally and ventrally; these, in general, longer posteriorly and toward the margin; derm with three and possibly more, distinct types of pores (see figures), somewhat triangular pores, but apparently with six loculi, corresponding to the usual trilocular, occurring both dorsally and ventrally; relatively large multilocular disk pores also both dorsal and ventral, and most abundant near posterior apex, and very rarely tubular ducts; also a large quadrilocular pore, probably a modified multilocular disk pore, and a very peculiar double tubular duct, possibly a modification of the normal type noted; body beneath, some distance behind the posterior legs with a pair of tiny truncate conical structures the exact nature and function of which can not be determined.

Immature stages.—None available.

Cotype.—Cat. No. 24765, U.S.N.M.

The writers have not had access to satisfactory study material of any of the other species which have been placed in this genus, all of which are American, and are therefore unable to comment on their status with relation to the type. The following genus diagnosis has been prepared only from the preceding description.

GENERIC DIAGNOSIS OF RIPERSIELLA.

Pseudococcine forms, probably altogether root inhabiting; adult female elongate oval, antennae short and stout, 6-segmented, placed very close together at the apex of the body, legs stout and short, with acute claw digitules and no denticle, mentum 2-segmented, two pairs of dorsal ostioles present, no cerarii developed, posterior pair and apical seta represented by three long setae, no specialized body spines, anal ring with six setae and large, faint areolations, without the usual rows of pores, derm with large multilocular disk pores, small somewhat triangular pores and tubular ducts, perhaps with other sorts, and with slender setae.

Genus CHAETOCOCCUS Maskell.

Plate 3, fig. 3.

Genotype.—*Sphaerococcus bambusae* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 120.

This genus was established by Maskell for a species he had formerly included in his genus *Sphaerococcus* because it had been discovered by Mr. E. E. Green that the type, *bambusae* had setae on the anal ring, while Maskell was of the opinion that *casuarinae*, the type of *Sphaerococcus*, had no anal ring setae; actually these two type species status with relation to the type. The following genus diagnosis has been discussed in detail previously in this paper and elsewhere.

This species is represented in the Maskell collection by five slides, one of "adult female, 1892," one of "2nd stage female, 1892," one of "antennae of female, 1892," and two of "larvae of female, 1892." There is also a small quantity of unmounted material bearing No. 221.

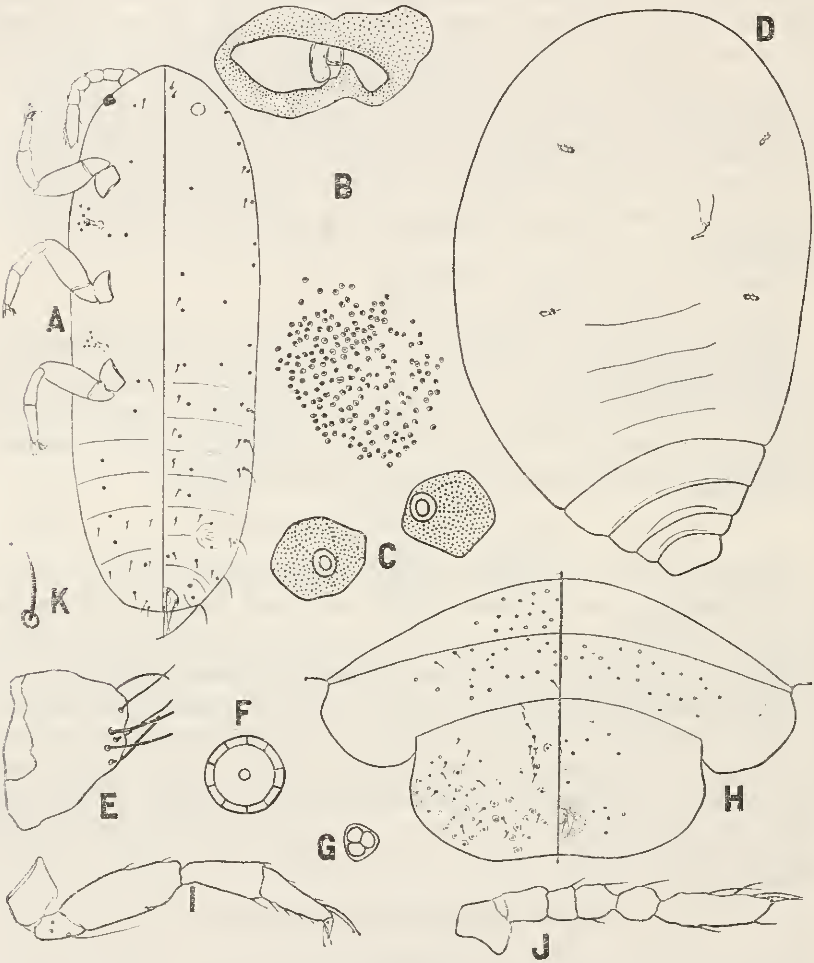

FIG. 18.—CHAETOCOCCUS BAMBUSAE (MASKELL). A. LARVA, OUTLINE, ×115; B. ADULT FEMALE, POSTERIOR SPIRACLE (ABOVE) AND PORE PLATE (BELOW), ×115; C. ADULT FEMALE, DETAILS OF PORES IN PLATE, ×1500; D. ADULT FEMALE, OUTLINE OF BODY, SHOWING SHAPE, ×12; E. ADULT FEMALE, ANTENNA, ×440; F. ADULT FEMALE, MULTILOCULAR DISK PORE, ×1500; G. SAME, TRIANGULAR PORE, ×1500; H. SAME, APEX OF ABDOMEN, ×440; I. LARVA, LEG, ×220; J. LARVA, ANTENNA, ×220; K. DERM SETA OF ADULT FEMALE, ×1500.

Adult female.—Occurring well down in the leaf sheaths in the midst of dense white waxy secretion, this surrounding but not covering the strongly flattened insect; body oval, pointed, and more or less strongly tapering behind, usually somewhat distorted and asymmetrical; derm at maturity heavily chitinized, brown, the abdominal seg-

ments strongly marked by lateral and dorsal constrictions; antennae reduced to minute unsegmented tubercles, placed at the anterior end of the body and each bearing about six small spines; legs entirely wanting; spiracles large, each set in a deep pocket in the chitinized derm, with a patch of small tubular glands behind each posterior spiracle; derm with numerous clear pores scattered over both surfaces, at the bottom of which are small triangular pores or tubular ducts; in addition with circular multilocular disk pores at the posterior end of the body; body setae all rather stout and short, a few at the posterior margin of the apical segment longer and more slender, the setae very rare except on the apical abdominal segments, where they are rather numerous ventrally, especially along the middle line; apical abdominal segment sometimes faintly bilobed; anal ring a heavy band placed a little dorsally and at the inner end of a short tubular invagination, ring bearing numerous small pores and six setae, slender and projecting a little beyond the circular opening of the tube.

Intermediate stage female (possibly adult before maturity).—Oval with the posterior apex of the body, only, chitinized and brown, the apical segment very broadly rounded, the remainder of the derm clear and membranous; antennae, mentum, legs and anal region as in adult, derm pores and setae along the margin of the body apparently much more numerous than in adult in proportion to size.

Larva.—Body elongate, parallel-sided, the ends rounded; antennae 6-segmented, the apical segment as long as the three preceding together; legs normal, rather slender, claw simple, digitules all long, slender, slightly knobbed; mentum short and stout, obscurely 2-segmented; derm with marginal rows of large triangular pores, dorsally with a submedian row of smaller but similar pores and an additional submarginal row anteriorly, ventrally also with a row of much smaller pores, this row submarginal posteriorly and submedian anteriorly, finally with a group of such pores at each spiracular opening; posterior dorsal ostioles conspicuous, anterior not noted; the abdominal segments with a pair of rather stout spine-like setae on each margin, one larger, one smaller, those on the apical segment large, the remainder gradually decreasing in size anteriorly, apical segment also with a pair of much longer, slender anal lobe setae; anal lobes developed only as very slight protuberances, with a few pores and six short slender setae.

Maskell placed one other species, first described by him as a *Sphaerococcus*, and now known as *Antonina graminis* (Maskell), in this genus in 1898. This species closely resembles *Sphaerococcus casuarinae* Maskell in size and shape, and when the intermediate stages are known may require a modification of the statement under *Sphaero-*

coccus that probably no other species originally included in that genus are really congeneric with the type, as *Sphaerococcus* is at present isolated on the basis of the presence of legs in the second stage of the female.

The following generic diagnosis is based on the preceding description.

GENERIC DIAGNOSIS OF CHAETOCOCCUS.

Modified Pseudococcine forms living partly surrounded by secretion in protected situations on the host; adult female large, oval, tapering, and somewhat pointed behind, flattened, heavily chitinized at maturity, antennae reduced to tiny tubercles, legs wanting, mentum indistinctly 2-segmented, dorsal ostioles obscure, no cerarii developed, body with spines, particularly posteriorly, and with multilocular disk pores, triangular pores, and tubular ducts, with a pore plate behind each hind spiracle, anal ring with pores, placed at inner end of invaginated tube, and with six setae protruding somewhat; larva elongate, parallel-sided, antennae 6-segmented, the apical long, legs normal, derm with longitudinal rows of trilocular pores and small slender setae, no definite cerarii, at least posterior dorsal ostioles present, with a pair of apical setae but no evident anal lobes, anal ring with pores and six slender setae.

This genus very obviously belongs with the group of modified Pseudococcine forms of which *Antonina* is the oldest described genus, and which also includes *Sphaerococcus* and possibly other, misplaced, genera. The writers consider *Chaetococcus* to be doubtfully distinct from *Antonina*, as this latter genus is commonly understood, the only apparent difference occurring in the very heavy thickening of the derm which developes all over the body of *Chaetococcus* at maturity, instead of merely on the posterior abdominal segments as in *Antonina*.

Genus KUWANINA Cockerell.

Genotype.—*Sphaerococcus parvus* Maskell.

References.—Fernald, Cat. Cocc. World, 1903, p. 121.—Green, Ent. Month. Mag., vol. 51, 1915, p. 181.—Ferris, Can. Ent., vol. 50, Oct. 1918, p. 324.

This genus was established by Cockerell in the Fernald Catalogue on the basis of the larval characteristics only, and with a single included species. One other species, *Sphaerococcus obscuratus* Maskell has recently been added to the genus by Ferris, but the writers have had no opportunity to study satisfactory material of this last species, and in view of the doubt expressed at the time of its reassignment, have decided to confine the generic diagnosis which follows to the type species.

The type species is represented in the Maskell collection by two slides, one of "adult female, 1897," and one of "larvae, 1897," There appears to be no unmounted material of the species.[12] It has fortunately been carefully redescribed by Green, and also discussed by Ferris (see reference), so the writers have limited their work on this species to the preparation of some illustrations and to giving a generic diagnosis.

GENERIC DIAGNOSIS OF KUWANINA.

Dactylopiine coccids (of the Fernald Catalogue) of uncertain position; adult female oval, posterior end somewhat more heavily chitinized and faintly nodulose, antennae tiny unsegmented tubercles with apical setae, legs wanting, mentum apparently 1-segmented, with small cribriform plate behind each posterior spiracle, derm

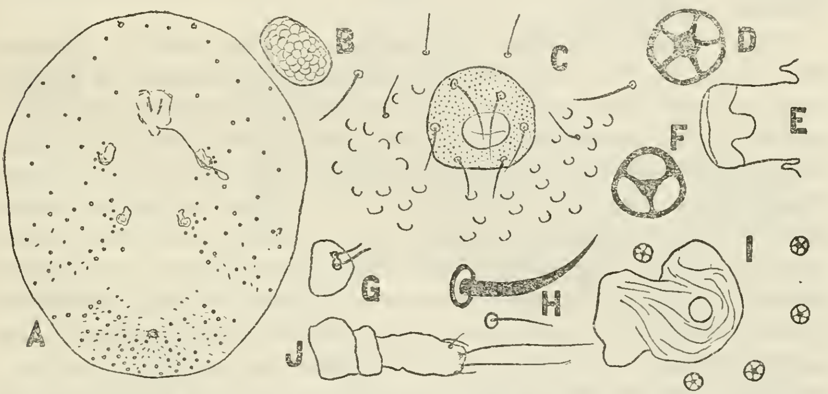

FIG. 19.—KUWANINA PARVUS (MASKELL). A. ADULT FEMALE, OUTLINE OF BODY, ×50; B. CRIBRIFORM PLATE OF ADULT FEMALE, ×640; C. ADULT FEMALE, ANAL RING REGION, ×640; D. ADULT FEMALE, QUINQUELOCULAR PORE, ×1500; E. SAME, SIDE VIEW, ×1500; F. ADULT FEMALE, TRILOCULAR PORE, ×1500; G. ADULT FEMALE, ANTENNA, ×640; H. ADULT FEMALE, SETAE, ×1500; I. ADULT FEMALE, SPIRACLE, ×640; J. LARVA, ANTENNA, ×640.

setae spine-like, small, scattered, more numerous posteriorly, derm pores normally quinquelocular, but varying from 3–7, also varying in size, set in bottoms of short tubes, anal ring small, heavy, entire, without pores, with six short setae; intermediate stage (from Green), body short oval, antennae 2-segmented, legs wanting, mentum 1-segmented, derm pores, etc., in general similar to those of adult; larva (from Green), rather elongate oval, antennae short, stout, 3-segmented, apical segment relatively very long, legs small, rather stout, derm pores sparse and irregularly scattered, anal ring simple, incomplete, with six short setae, body with a pair of apical setae.

The writers are able to contribute nothing new in regard to this genus.

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[12] Unmounted and unlabeled material of this species has subsequently been located in the Maskell Collection under lot No. 560. *Cotype.*—Cat. No 24766, U.S.N.M.

Subfamily Coccinae.

Genus CERONEMA Maskell.

Plate 3, fig. 4.

Genotype.—*Ceronema banksiae* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 127.

At the time of original description, Maskell included only the type species in this genus, although he later added another to it.

Ceronema banksiae is represented in the Maskell collection by three slides, one of "adult female, 1894," one of "2nd stage female, 1894," and one of "larvae, 1894," and by a single unmounted adult female specimen, two ovisacs and a male puparium bearing No. 421. Maskell appears to have described the different stages with considerable accuracy, so the following notes are to some extent a repetition of his work.

Adult female.—External appearance as described by Maskell. body elongate oval, more or less asymmetrical, flattened, or slightly convex, dorsal derm heavily chitinized except along margin of body, punctured by numerous pores, anal plates placed close to the posterior apex; antennae 6-segmented, third very long; legs normal. small, rather slender, claw stout, with denticle, digitules slender, long, knobbed at apices; mentum not discernible; spiracles normal for the group; marginal spines rather long, slender, acute setae, usually separated by several times the length of one; spiracular spines about 5–7 in each group, all stout and bluntly rounded, but varying greatly in size, the end of the spiracular groove marked by a curved chitinized thickening; dorsal derm with an occasional tiny spine set at the end of a clear pore; dorsally with three types of pores, small simple circular pores, larger tubular ducts and much larger tubular ducts, these at intervals along the margin and apparently corresponding to the marginal tubercles so conspicuous in some Lecanine species, the first two numerous over most of the surface, except in a median longitudinal area, the last with about 33 around the body margin, with similar, but less developed and smaller pores intervening between many of the larger ones, to the number of 20; ventrally along the body margin with numerous long tubular ducts, similar to but much smaller than the second type described for the dorsum, and with two sorts of multilocular disk pores, the larger with, usually, six loculi, in the anal region, the others, somewhat smaller and usually with five loculi, between spiracles and margin of body; anal plates each more than twice as long as wide, the anterior halves of the pair almost forming a semicircle, but the posterior half of each tapering, slender, forming almost a rounded point at the apex, plates without dorsal setae, with four

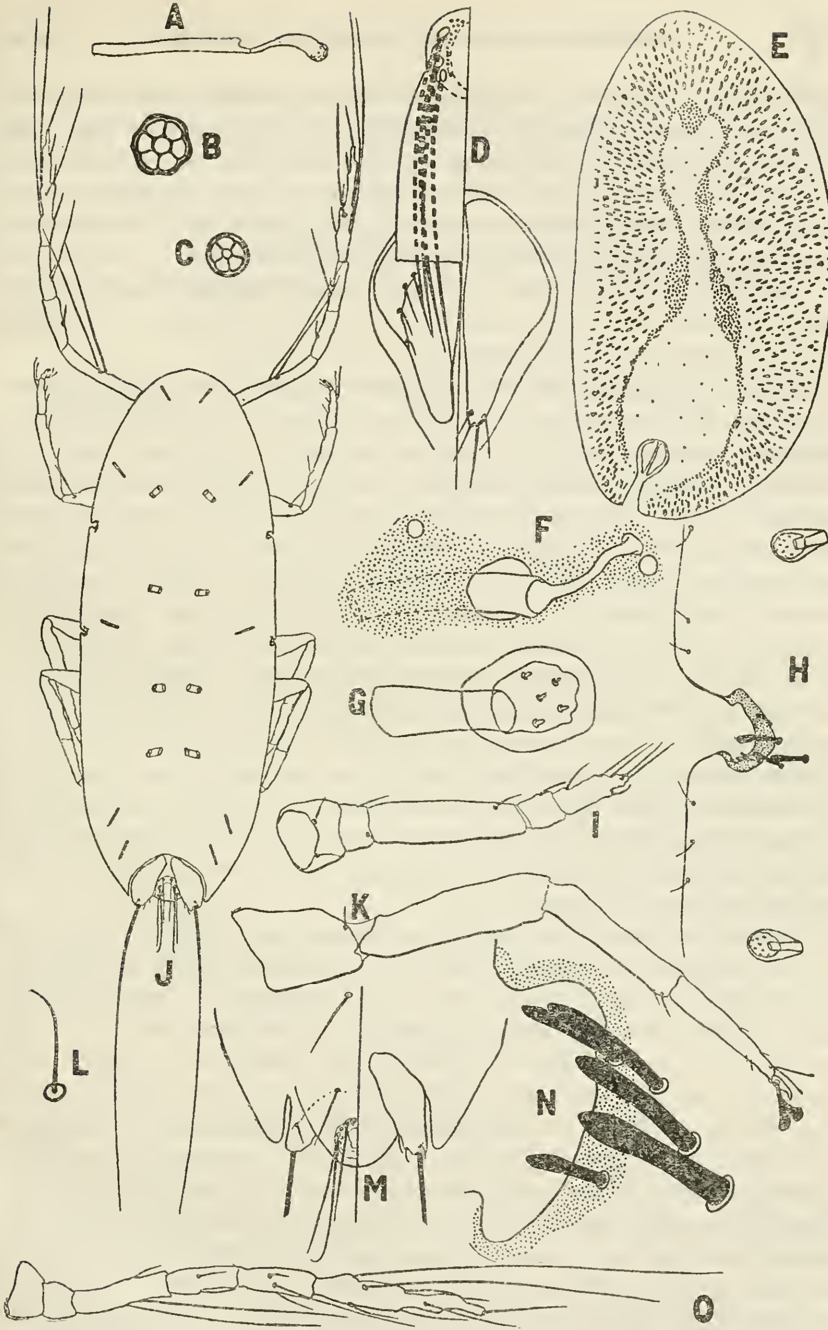

FIG. 20.—CERONEMA BANKSIAE MASKELL. A. ADULT FEMALE, VENTRAL TUBULAR DUCT, ×500; B. SAME, MULTILOCULAR DISK PORE NEAR ANAL PLATES, ×1500; C. SAME, MULTILOCULAR DISK PORE BETWEEN SPIRACLES AND MARGIN, ×1500; D. SAME, ANAL PLATES, ×115; E. SAME, DORSAL VIEW, ×17.5, SHOWING SHAPE, ARRANGEMENT OF PORES AND SUBMARGINAL TUBERCLES; F. SAME, DORSAL TUBULAR DUCT, ×500; G. SAME, "SUBMARGINAL TUBERCLE," ×500; H. SAME, PORTION OF MARGIN OPPOSITE SPIRACLE, ×165; I. SAME, ANTENNA, ×165; J. LARVA, OUTLINE FROM ABOVE, ×115; K. ADULT FEMALE, HIND LEG, ×165; L. SAME, MARGINAL SPINE, ×650; M. LARVA, ANAL PLATES, ×220; N. ADULT FEMALE, SPIRACULAR SPINES, ×640; O. LARVA, ANTENNA, ×220.

apical setae, unequal in length, but one much longer, on each, ventral ridge placed along the outer edge of each plate, curving with the outline, bearing four setae at wide intervals, the two anterior ones quite long; apparently without fringe or hypopygial setae; anal ring placed some distance anterior to the plates, small, oval, stout, bearing pores and apparently eight large setae.

Intermediate stage female.—No material available (Maskell's 2nd stage female, in the opinion of the writers, nothing more than a badly parasitized adult female).

Larva.—Elongate, broadest in thoracic region, head rounded, tapering gradually behind, apex of abdomen rounded; antennae long and slender, 6-segmented, the terminal segment very long; legs very slender, digitules slender, knobbed, one of the tarsal inserted much above the other, the latter smaller, claw with denticle near tip; mentum very short triangular, 1-segmented; spiracular spines in threes, the median larger, all stout, bluntly rounded at apices; marginal spines very minute if present at all; with five long, slender submarginal tubular ducts on each side of the body, and with three or four pairs of much larger and relatively stouter tubular ducts in a median row, one pair before the mouthparts, one pair behind, and one or two pairs on the anterior portion of the abdomen, all dorsal; anal plates slender, not reticulated, bearing a long apical seta about half the length of the body, one outer and two inner curved and two ventral straight much smaller slender setae; also with a pair of much larger submedian ventral setae anterior to the anal ring; anal ring with pores and six setae.

Besides the type, four species have been placed in this genus. Of these, *Ceronema dryandrae* Fuller is described as being very similar to *banksiae*, and can probably remain in the genus; *C. caudata* Froggatt might from its similar superficial appearance, and from the analogy of identical general distribution, easily be congeneric with *banksiae*, but the description gives only the external appearance of the insect, omitting morphological details entirely, so no definite statement on its proper position is possible. An examination of the type specimens (slides) of *C. japonica* Maskell shows that the double anal plates remarked on by the describer are due to his having prepared mounts from preadult individuals just ready to moult. On account of the condition of these specimens, it is difficult to comment accurately on the generic affinities of the species. It does not appear to be congeneric with *C. banksiae* in morphological characters, the chief differences lying in the marginal and spiracular spines and the anal plates, in the older stages, and in the more oval shape, the much shorter and stouter legs and antennae and the absence of large tubular ducts in the larva of *C. japonica.* A similar comment appears to apply to *C. koebeli* Green, in so far as this can be determined from

Green's elaborate figures and description. *C. africana* McFie also differs in morphological characters from the type of the genus, and can hardly be included in it on such grounds. The writers are not able to suggest any other genus location for the last three species discussed, but do believe that, at most, only the three Australian species can be legitimately included in the genus *Ceronema.*

The following generic diagnosis is based almost wholly on the type species:

GENERIC DIAGNOSIS OF CERONEMA.

Coccine forms (of Fernald Catalogue), female at maturity surrounded by a heavy secretion of waxy threads covering all of the body except a portion of the dorsum; adult female with heavily chitinized dorsal derm with numerous pore canal punctures, 6-segmented antenna, normal legs, normal spiracles, slender acute marginal setae, numerous, stout, bluntly rounded spiracular spines in the usual four groups, each accompanied by a chitinized plate, with minute setae dorsally, derm pores dorsally of three types, minute simple pores, large tubular ducts and "submarginal tubercles," all numerous, ventral pores small tubular ducts and two sizes of multilocular disk pores, anal plates slender, tapering posteriorly, no dorsal setae on these, some apical setae, a few ventral setae, no fringe setae apparently, no hypopygial setae, anal ring placed anterior to plates, small, with pores and eight setae; larva elongate, tapering posteriorly, legs and antennae very long and slender, spiracular spines subequal in length, all stout, blunt, with submarginal and submedian large conspicuous tubular ducts, anal ring with 6 setae, anal plates slender, not reticulated, bearing an apical seta about half as long as body.

The characters presented by the type of this genus seem quite sufficient to justify its retention.

Genus ERIOCHITON Maskell.

Plate 3, fig. 5.

Genotype.—Eriochiton hispidus Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 127.

The type of this genus was automatically set by Maskell in describing it with only the single included species, although the first definite statement regarding a type species appears to be that in the Fernald Catalogue.

The Maskell collection contains only a single slide of the species labeled "adult female from Olearia, 1880," and a few unmounted specimens in different stages under No. 59. From the latter it has been possible to obtain mounts of the larva.

Adult female.—Short oval, almost elliptical, slightly convex, derm clearing completely on boiling in potassium hydroxide; antennae

7-segmented, rather slender; legs small, normal, digitules slender, slightly knobbed, claw with a denticle, tarsus considerably longer than tibia; ventral surface between anterior and intermediate legs and around mentum more heavily chitinized, bulging into symmetrical

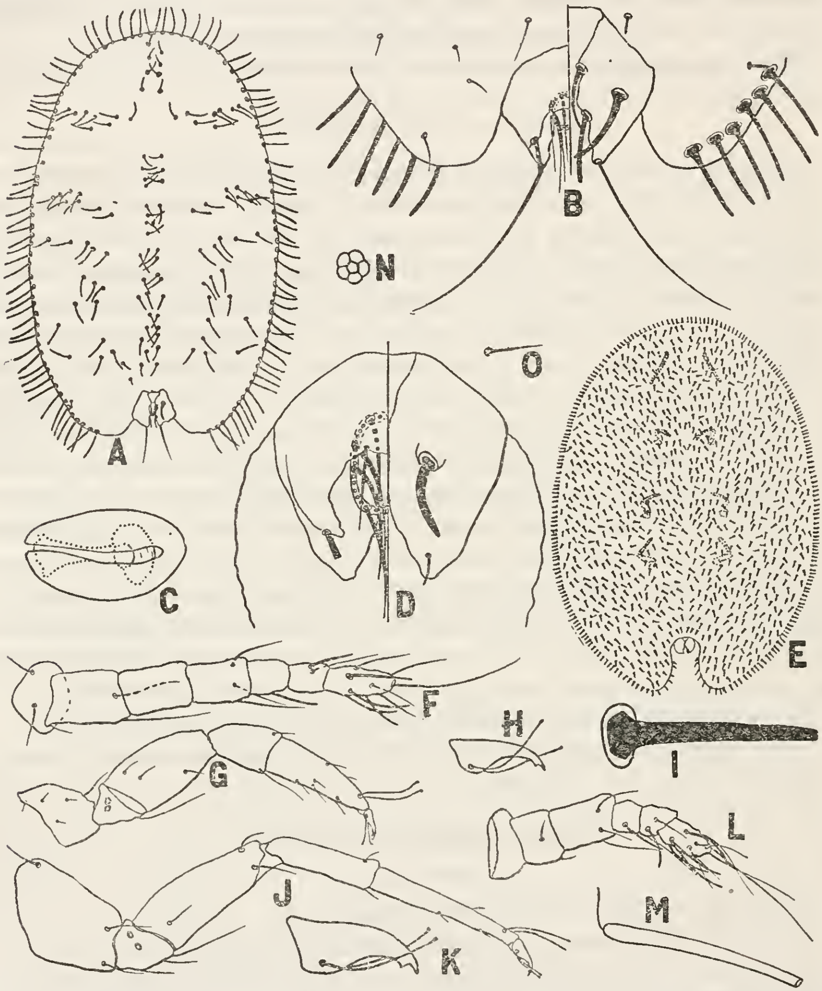

FIG. 21.—ERIOCHITON HISPIDUS MASKELL. A. LARVA, ×115; B. LARVA, APEX OF ABDOMEN, ×335; C. ADULT FEMALE, SPIRACLE, ×335; D. ADULT FEMALE, ANAL PLATES, ×220; E. ADULT FEMALE, OUTLINE OF BODY, DORSAL, ×17.5; F. ADULT FEMALE, ANTENNA, ×165; G. LARVA, LEG, ×220; H. SAME, CLAW SHOWING DIGITULES AND DENTICLE, ×640; I. ADULT FEMALE, BODY SPINE, ×500; J, ADULT FEMALE, MIDDLE LEG, ×165; K, SAME, CLAW, ×640; L. LARVA, ANTENNA, ×220; M. ADULT FEMALE, TUBULAR DUCT, ×1500; N. ADULT FEMALE, QUINQUELOCULAR PORE, ×1500; O. ADULT FEMALE, VENTRAL SETA, ×500.

folds partly overlapping the mentum below, the latter apparently 1-segmented; whole dorsal surface with numerous long, but fairly slender, somewhat tapering truncate spines, these more numerous in a row along the margin; spiracular spines not differentiated; dorsal

surface with some small, slender setae in addition to the spines; ventral derm with some larger slender setae; with only tiny, long-tubular ducts occasionally near the margin, and with tiny quinquelocular pores near the spiracles, and a few similar but slightly larger beneath the anal plates; these stout broad, each about half or a little more as wide as long, broadest before the middle, tapering behind, both the inner and outer margins curving so the tips are well separated, dorsally with a large stout spine before the middle and a subapical seta, apparently without apical setae, ventrally with a strong seta, flattened and expanded apically, at the posterior end of the ventral ridge, and with a single large fringe seta on each side; anal ring placed within the plates, rather large, oval, slender, with a single row of pores and eight stout setae; hypopygial setae wanting.

Intermediate stages.—None available for examination.

Larva.—Body oval, broadest at or before the middle, the two ends bluntly rounded, whole margin of the body with a single row of long, slender, blunt-tipped spines; with a median longitudinal double row of similar but smaller spines, three transverse rows of similar spines on head and thorax, and an additional longitudinal double row on each half of the abdomen; spiracular spines not differentiated; dorsum without other setae, ventrally with an occasional tiny slender seta; with slender tubular ducts along the body margin, no other pores noted; antennae 6-segmented, legs normal, rather stout, claw with denticle; anal plates more or less invaginated within margin, stout, irregular in shape, bearing a slender hair at apex, a stout blunt spine of unusual shape, expanded at apex, latero-ventrally, and still a third anterior to this, and much smaller, dorsally with a large stout, blunt-tipped spine, similar to the marginal spines mid-dorsally, and two similar but smaller spines arising from the inner margin of each plate; anal ring apparently with six setae.

Cotype.—Cat. No. 24767, U. S. N. M.

Two other species have been included in this genus, one of which, *E. spinosus* (Maskell), is quite obviously congeneric with the type, differing conspicuously only in the fact that the dorsal truncate spines are very few in number and are confined largely to the median longitudinal area. The other species, *E. theae* Green, differs so decidedly from the type species in certain morphological characters, notably the conspicuous differentiation of the spiracular spine groups and the development of longitudinal submedian clusters of conical spines, as to make its elimination from the genus desirable. As has already been noted, Maskell's specimens of *Ceronema japonica* are apparently preadult, so it is not possible to state definitely that Mr. Green's intimation at the time he described *theae*, that his species might be the same as *C. japonica* is correct. However, from a comparison of Green's care-

ful description with Maskell's types, it is possible to state that the two are very plainly congeneric, and that of the differences suggested by Green,[13] only that of the number of antennae segments stands, and even this can be accounted for on the basis of immaturity. The early stage of the Maskell specimens would preclude the formation of a complete test, and the anal ring actually has six setae, such as Green described for *E. theae*, instead of eleven as figured by Maskell. As a matter of opinion, the writers consider the two to be the same species.

The following generic diagnosis has been based upon the two Maskell species from New Zealand.

GENERIC DIAGNOSIS OF ERIOCHITON.

Coccine forms of the Fernald Catalogue, the adult female enclosed in a test composed of compact felted secretion, this test more or less complete; adult female elliptical, antennae 7-segmented, legs small, normal, claw with denticle, mentum 1-segmented, margin and dorsum of body with long, slender, blunt-tipped spines more or less numerously developed, spiracular spines not differentiated, dorsal and ventral surfaces with some slender setae, only small, slender, long-tubular ducts and tiny quinquelocular disk pores present on body, anal plates stout, broad, with a large stout, blunt dorsal spine and some setae, with one large fringe seta on each side, hypopygial setae wanting, anal ring with pores and eight setae; larva stout, antennae 6-segmented, legs stout, normal, claw with denticle, at least the margin of the body with a fringe of long, slender, blunt-tipped spines, spiracular spines not differentiated, only long tubular ducts present, at margin, anal plates more or less retracted, stout, with stout spines and setae, anal ring with pores and six setae.

Genus MALLOCOCCUS Maskell.

Plate 4, fig. 1.

Genotype.—*Mallophora sinensis* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 142.

Mallococcus is a new name substituted by Maskell for the genus name *Mallophora*, established by him for the single species *sinensis*, a name which proved to be preoccupied.

There are four slides of the type of this genus in the Maskell collection, one of "adult female, 1896," one of "abdomen of female, 1896," one of "antenna of female, 1896," and one of "larva, 1896." There is in addition a little unmounted material under No. 512.

Adult female.—"Covered by a closely-felted secretion"—(Maskell), this, in the dried material a dense but brittle, almost homogeneous test; body stout, elliptical, almost circular, shriveling into a

[13] Ind. Mus. Notes, vol. 5, 1900, p. 11.

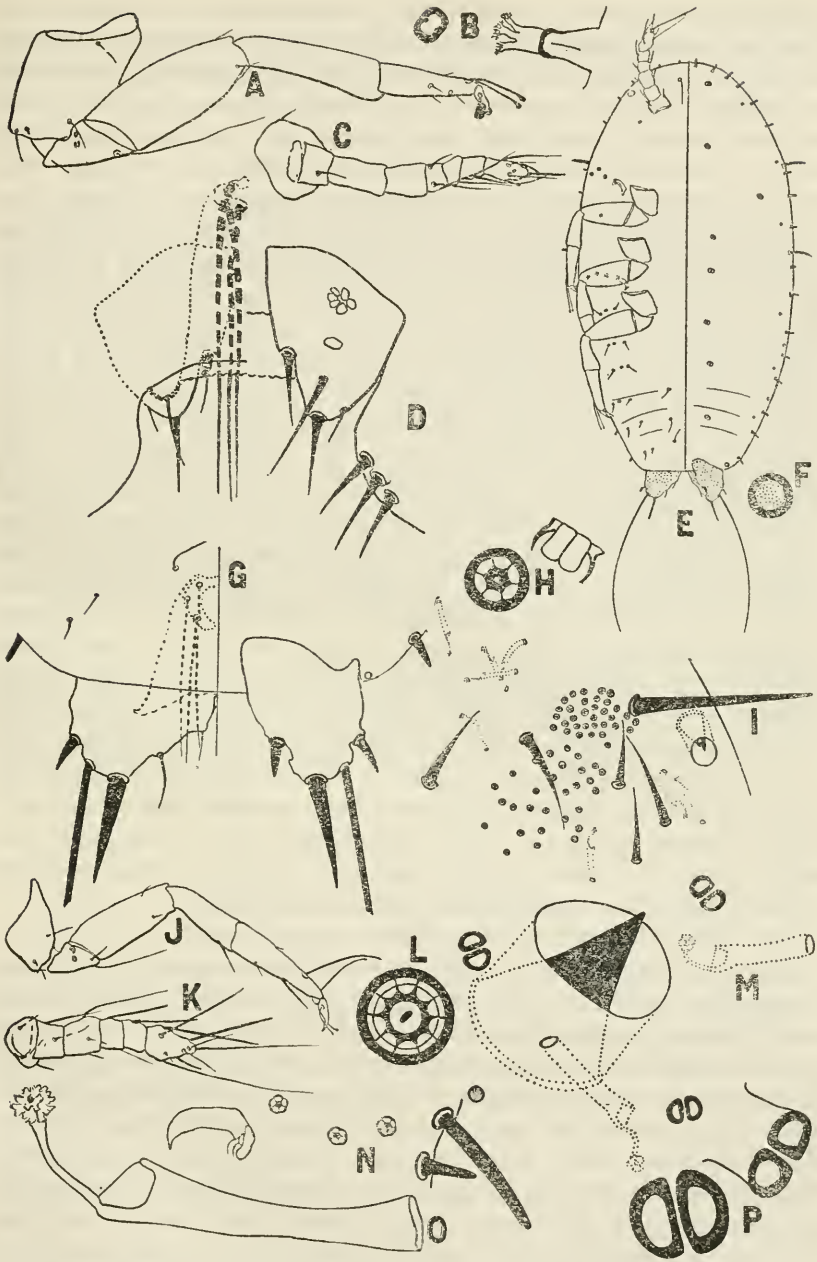

FIG. 22.—MALLOCOCCUS SINENSIS (MASKELL). A. ADULT FEMALE, LEG, ×165; B. ADULT FEMALE, SMALL 8-SHAPED PORE, ×1500; C. ADULT FEMALE, ANTENNA, ×115; D. ADULT FEMALE, ANAL PLATES (FROM SPECIMENS LOANED BY PROF. G. F. FERRIS, NOT FROM TYPE MATERIAL), ×440; E. LARVA, ×115; F. ADULT FEMALE, DISK PORE, ×1500; G. LARVA, "ANAL PLATES," ×440; H. ADULT FEMALE, SPIRACULAR DISK PORE, ×1500; I. ADULT FEMALE, SPIRACULAR SPINE REGION, ×165; J. LARVA, MIDDLE LEG, ×220; K. LARVA, ANTENNA, ×220; L. ADULT FEMALE, DISK PORE NEAR ANAL RING, ×1500; M. ADULT FEMALE, DETAIL OF DORSAL SPINE AND ADJACENT AREA, ×640; N. LARVA, SPIRACLE TO MARGIN, ×640; O. ADULT FEMALE, TUBULAR DUCT, ×1500; P. ADULT FEMALE, 8-SHAPED PORE, TWO VIEWS, ×1500.

small distorted mass at the anterior end of and free from the test after producing young; venter of abdominal segments more heavily chitinized; antennae, 7–8-segmented, the third usually somewhat the longest; legs rather slender, claw stout, without denticle; tarsal digitules slender, long, with stout knob, claw digitules large and broad, with large knob; spiracles short and stout, strongly constricted; mentum stout, short triangular, 2-segmented; body dorsally with fairly numerous, but scattered, large, stout, conical spines, invaginated their whole length within the body, arranged in indefinite transverse rows and more numerous near the margin; body along margin with a single to triple row of slender, very acutely pointed spines; spiracular spines represented by a single one, about twice as long as the marginal, slender, but stouter near the tip than the marginal, and bluntly rounded at apex, opposite each spiracle; ventrally with pairs of long hairs on the segments anterior to the anal ring; dorsally with numerous 8-shaped pores, these clustered in indefinite fashion around the large conical invaginated spines, with a few small circular pores, and with numerous slender tubular ducts with deep, cup-shaped bottoms, and slender prolongations scattered promiscuously; ventrally with similar ducts, with transverse rows of larger multilocular-disk pores, and, finally, with some small tubular ducts, the disk pores with about eleven loculi placed anterior to the anal ring; those, about half as large, with five or six loculi, scattered between each spiracle and its marginal spine, each row of these terminating in a dense cluster at the base of the spine; anal ring small and stout, with pores and six setae, surrounded by a pair of curved plates, flat, short, and deep—that is, long dorso-ventrally, somewhat pitted above, each bearing four setae, and one ventral ridge seta; a single fringe seta on each side.

Intermediate stages.—Not available for examination.

Larva.—Elongate oval, somewhat broader anteriorly; antennae 6-segmented, terminal segment longest, legs normal, claw with denticle, all digitules slender, knobbed, one tarsal digitule inserted above the other and slightly longer; mentum stout triangular, apparently 1-segmented; with a single long, cylindrical, blunt-tipped spiracular spine opposite each spiracle; margin of body with a row of short, blunt, tapering spines, about one to a segment, and a submarginal row of tiny, apparently simple pores, dorsally with a submedian longitudinal row of 8-shaped pores on each side, ventrally with two or three longitudinal rows of slender setae and a single row of tiny pores on each half, also with two or three multilocular disk pores between each spiracle and its spine; anal plates protruding, each chitinized, bearing one apical spine, two smaller spines, one slender apical seta, and a smaller seta; anal ring with pores and six setae.

Cotype.—Cat. No. 24768, U.S.N.M.

One other species, *M. lanigerum* (Hempel.) was doubtfully included in this genus according to the Fernald Catalogue, but it is obviously not related to the type at all, and the following generic diagnosis is therefore based wholly on the type species.

GENERIC DIAGNOSIS OF MALLOCOCCUS.

Apparently Coccine forms having the adult female enclosed in a test composed of waxy threads, ovate, with well-developed legs and antennae, the latter 7–8 segmented, 2-segmented mentum, a single spiracular spine opposite each spiracle, slender, acutely pointed marginal spines, numerous large, conical dorsal spines, invaginated their whole length into the derm, numerous small 8-shaped pores dorsally, small slender tubular ducts and minute circular pores both dorsally and ventrally, and two sizes of multilocular disk pores ventrally, anal ring with pores and six setae, surrounded by a pair of "plates united below, free above; larva elongate oval; antennae 6-segmented, legs normal, claw with denticle, spiracular spines single, margin with small but stout spines, with a dorsal submedian row of 8-shaped pores on each side, anal lobes protruding, bearing an apical seta and stout spines.

In certain respects this genus resembles some members of the subfamily Asterolecaniinae so much that it stands either as a remarkable example of parallel modification or as a connecting unit indicating a relationship between the two groups of genera.

Genus LECANOCHITON Maskell.

Plate 4, fig. 2.

Genotype.—Lecanochiton metrosideri Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 147.

Lecanochiton was established by Maskell with a single included species, which therefore stands as the type. The small amount of material available for examination and the peculiar nature of the species has made this type a most difficult and unsatisfactory one to study, and fresh, and perhaps living material is much needed to straighten out some points in its anatomy and to verify statements made here.

The Maskell collection contains a single slide of "tests of adult from Rata, Jan. 1881," and a little unmounted material bearing No. 31.

Adult female.—Circular, convex, shaped like an inverted basket, covered by a test having the cast second stage skin in the middle of the dorsum (Maskell); anal cleft relatively long, dorsum heavily chitinized, venter slightly so, both clearing somewhat in potassium hydroxide so the venter becomes transparent; antennae apparently

3-segmented, legs apparently wanting; mentum apparently 1-segmented, spiracles small; marginal setae and spiracular spines apparently wanting; no dorsal or ventral surface setae noted; dorsally with scattered, small, slender tubular ducts penetrating the chitin through small clear openings, and a row of small closely set pores through the chitin running forward from the anal plates on each side of the median line for a short distance; ventrally with only tiny quinquelocular disk pores, these a few near the spiracles,

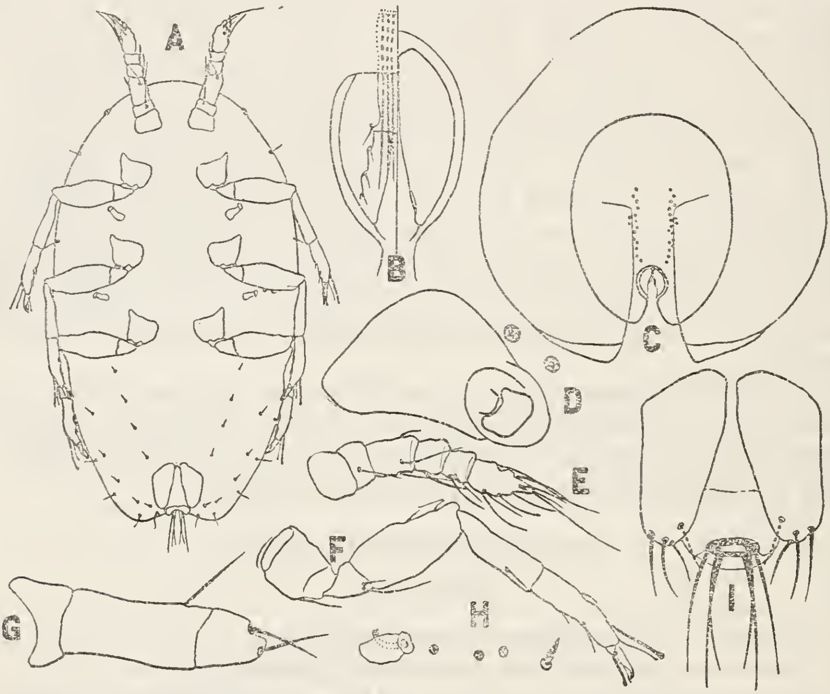

FIG. 23.—LECANOCHITON METROSIDERI MASKELL. A. LARVA, OUTLINE, VENTRAL, ×165; B. ADULT FEMALE, ANAL PLATES, ×220; C. ADULT FEMALE, OUTLINE FROM ABOVE, ×32; D. ADULT FEMALE, SPIRACLE, ×640; E. LARVA, ANTENNA, ×335; F. LARVA, LEG, ×335; G. ADULT FEMALE, ANTENNA, ×440; H. LARVA, SPIRACLE AND SPINE, ×500; I. LARVA, ANAL PLATES, ×640.

continued into a row of widely scattered pores running to the body margin, around this, and for some distance onto the dorsal surface; no similar pores noted near the anal plates; anal plates small, slender, tapering, with a short, stout apical seta, one or two dorsal setae placed behind the middle, with three ventral ridge setae and with a single fringe seta on each side; anal ring set just anterior to the plates, small, with pores and apparently six setae.

Larva.—Elongate oval, antennae 6-segmented, legs normal, all digitules knobbed at apices, one of the tarsus longer and stouter than the other, one of the claw stouter than the other, claw without den-

ticle; margin of body with a single row of rather long, slender setae, spiracular spines stout, short, apices rounded, occurring singly, shorter than marginal setae, the latter accompanied by ventral submarginal and submedian rows of much smaller setae; anal plates each half-oval, with three apical and subapical setae, all short, and one ventral seta; anal ring small, with pores and six setae.

Cotype.—Cat. No. 24769, U.S.N.M.

In 1890 Maskell described another species in this genus, an examination of a specimen of which shows that it is very closely related to the type, although on the basis of the scant material available apparently distinct. This species is *L. minor* Maskell. The following generic diagnosis has been prepared from both these species, but even then is incomplete in many respects, and is subject to revision on the basis of the study of more satisfactory material.

GENERIC DIAGNOSIS OF LECANOCHITON.

Coccine forms (of Fernald Catalogue), adult female with the exuvium of the preceding stage remaining attached to the middle of the dorsum, at least appearing as if covered by a hard test; dorsal derm heavily chitinized, body circular, convex, antennae present, size and number of segments reduced, legs wanting, mentum 1-segmented, spiracular spines wanting, marginal setae wanting, no dorsal or ventral derm setae, with slender tubular ducts dorsally and quinquelocular pores of one size ventrally adjacent to the spiracles, anal plates slender, with dorsal, apical, and ventral setae, one pair of fringe setae, no hypopygial setae, anal ring small, with pores and six setae; larva oval, antennae 6-segmented, legs normal, marginal setae slender, spiracular spines single, stout, rounded at apex, anal plates half-oval, with apical setae, anal ring with pores and six setae.

Between the uncertainty in regard to some of the structural characters of the included species and the confusion existing in the generic classification of the subfamily in which the genus belongs the writers are unable to offer any suggestions as to its relationships; the apparent retention of the exuvium of the preceding stage by the adult female appears to provide a distinguishing identification character which can be used until the true relationships of the genus have been determined.

Genus CTENOCHITON Maskell.

Plate 4, fig. 3.

Genotype.—*Ctenochiton viridis* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, pp. 159, 161.

In spite of the fact that this genus was described in 1879, the first designation of a type species for it does not appear to have been made

until the publication of the Fernald Catalogue in 1903, at which time *viridis* was indicated as the type.

The Maskell collection contains three slides of the type species, one of "old females from Rubus, June, 1877," one of "Female, early 3d stage, Jan. 1890," and one of "Adult male, 1890," and some unmounted specimens under No. 33. It has been possible to obtain additional mounted specimens from this latter material, and most of the following descriptive notes have been obtained from these later mounts. There is no positive evidence, however, that the unmounted specimens were from the original type lot of material.

Adult female.—Bright green in life (Maskell); very flat in dried state, broadest behind, somewhat acuminate and asymmetrical anteriorly; test incomplete and broken in old forms; derm not very heavily chitinized; antennae small, slender, 6-segmented, the third very long; legs small, normal, the claw very short and stout, the tarsal digitules slender, knobbed, the claw digitules more flattened and expanded through their whole length; mentum very short, broad, apparently 1-segmented; margin of body with a row of widely separated, small, conical spines, placed about 4–5 times their own length apart; spiracular spines represented by a single long spine opposite each spiracle; no dorsal setae observed; ventrally with long hairs near the antennae, and in pairs anterior to the anal plates, and also with some small scattered hairs; dorsally with tiny tubular ducts, widely scattered and each surrounded (in stained specimens) by a small, circular, clear area, also with a short transverse row of tiny disk pores some distance anterior to the anal plates and a few similar along the body margin; ventrally with a scattered row of quinquelocular disk pores between each spiracle and the margin, and with numerous larger multilocular disk pores in transverse and encircling bands anterior to and around the anal plates; these latter circular to oval with as many as eleven to twelve loculi and oval centers, also with the tubular ducts ventrally, at least near the margin; anal plates, when flattened, broad and stout, tapering to a blunt point posteriorly, with a slender apical spine, two similar, subapical, on the inner face of each plate, and (probably) a much larger subapical dorsal seta (represented only by the clear spot in the chitin to which the base was presumably attached), with two ventral setae near the base of the ridge, fringe setae apparently wanting; anal ring with six setae, one pair larger and longer than the others, and a double row of pores, placed a little anterior to the anal plates.

Intermediate stages.—Not available.

Larva—(embryonic only). Broad ovate, slightly narrowed behind; antennae 6-segmented; legs normal, claw without denticle, tarsal digitules knobbed, one much stouter than the other, the more slender inserted a little above the other, claw digitules similar, one much

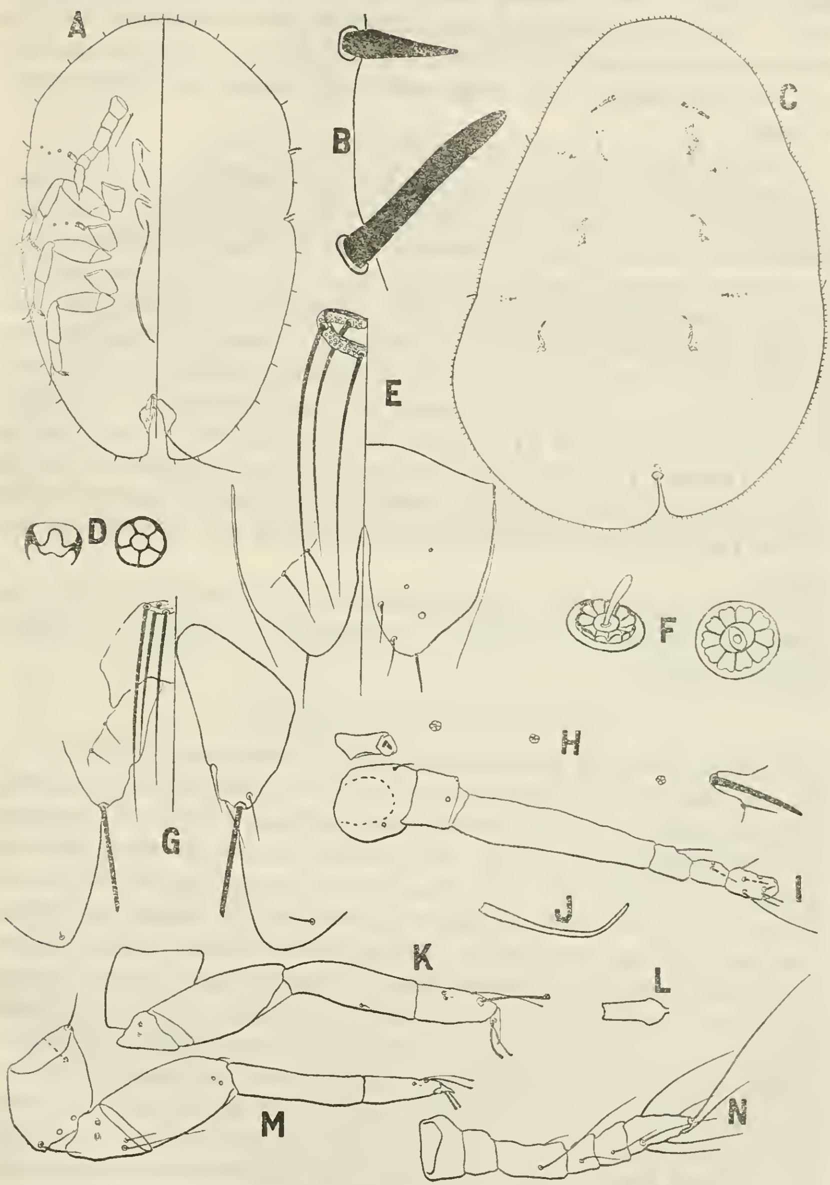

FIG. 24.—CTENOCHITON VIRIDIS MASKELL. A. LARVA, ×115; B. ADULT FEMALE, SPIRACULAR AND MARGINAL SPINES, ×500; C. ADULT FEMALE, OUTLINE, ×12; D. ADULT FEMALE, SPIRACULAR DISK PORE, ×1500; E. ADULT FEMALE, ANAL PLATES, ×165; F. ADULT FEMALE, DISK PORES ANTERIOR TO ANAL PLATES, TWO VIEWS, ×1500; G. LARVA, ANAL PLATES, ×640; H. LARVA, SPIRACLE TO MARGINAL SPINE, ×640; I. ADULT FEMALE, ANTENNA, ×165; J. ADULT FEMALE, TUBULAR DUCT, ×1500; K. LARVA, LEG, ×335; L. ADULT FEMALE, DUCT, ×1500; M. ADULT FEMALE, LEG, ×165; N. LARVA, ANTENNA, ×335.

stouter than the other; spiracular spines single, relatively large and stout, margin with a widely separated row of small slender setae; with 2–3 tiny quinquelocular disk pores between each spiracle and its spine, no other pores noted; anal plates triangular, with a long apical seta, not reticulated; anal ring small, with pores, and, apparently, six setae.

Cotype.—Cat. No. 24770 U.S.N.M.

A considerable number of species has been included in this genus, and while it is not possible to comment accurately regarding the disposition of most of these, on account of the confusion existing in this and related genera, it seems probable that most of the New Zealand sepecies now included here are rather closely related to the type and may be left in the genus for the present; *C. eucalypti* Maskell and *C. rhizophorae* Maskell do not appear to be congeneric with the type, but we can not indicate their proper location at present; *C. cellulosa* Cockerell appears to be a *Ceroplastodes* in the sense of *Ceroplastodes cajani* (Maskell), which in turn is probably not congeneric with the type of *Ceroplastodes.* Beyond these, no suggestions can be offered at this time as to the remainder of the species now included in the genus.

The following generic diagnosis has been prepared chiefly from the description of the type species, with reference to some of the other included species.

GENERIC DIAGNOSIS OF CTENOCHITON.

Coccine forms (of Fernald Catalogue); adult female more or less convex, usually very slightly so, covered in life with glassy, whitish, or transparent wax plates, these often fragile and broken or wanting, projecting beyond the body margin like saw teeth when perfect; antennae 6–8-segmented, the third usually long; legs and spiracles normal, the claw digitules somewhat swollen, claw with or without denticle, mentum 1-segmented, marginal setae small, conical spines set variably from very close together to some distance apart, according to the species, spiracular spines single, large, strongly differentiated, dorsal setae wanting or very small, dorsal spines present in a definite pattern in some species, ventral setae few, not conspicuous, derm with tiny tubular ducts and, ventrally, with two sizes of multilocular disk pores, with or without other types of pores, anal cleft short, plates small, tapering behind, with apical and subapical setae and a large dorsal pore (or hair base), with ventral ridge setae, without fringe setae, without hypopygial setae, anal ring placed anterior to plates, with six setae and double row of pores; larva ovate, antennae 6-segmented, legs normal, spiracular spines occurring singly, marginal setae small, slender, spiracular disk pores present, anal

plates triangular, with long apical seta, anal ring small, with pores and six setae.

Genus INGLISIA Maskell.

Plate 4, fig. 4.

Genotype.—Inglisia patella Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, pp. 162, 163.

Inglisia was first described by Maskell in 1879, and originally included only the single species *patella*, which consequently stands as the type.

This species is represented in the Maskell collection by a single slide of "rostrum, antennae, foot, and spiracle, June, 1881," and by a very few unmounted specimens under No. 46. There is thus no indication that Maskell retained in his collection the specimens he studied when describing the species and genus, and it seems probable that they are no longer in existence. The species is so distinct in certain structural characters, however, that there would seem to be no question as to the identity of the later material with that originally described.

Adult female.—The glassy external covering, as described by Maskell, that is limpet-shaped; body indistinctly eight-sided, anal cleft very short, derm clearing completely in potassium hydroxide, convex above, but flattening without injury on mounting; antennae small and short, indistinctly 7-segmented; legs small, short, normal, joint between tibia and tarsus somewhat indistinct, tarsal digitules slender, knobbed, but one larger than the other, claw digitules enlarged, both swollen at tips, claw small and stout, without denticle; mentum 1-segmented, small; spiracles small, not strongly constricted in middle; marginal spines small, short, of two distinctly different sorts, one stout, clavate, the other slender, tapering, straight, both set in cup-shaped sockets and normally alternating; spiracular spines not differentiated, their location indicated only by a slight marginal indentation and a few quinquelocular pores; both dorsally and ventrally with a few tiny, slender setae, especially near the margin, and with a transverse row of the same some distance anterior to the anal plates; with only slender tubular ducts, mostly along the margin, probably dorsally and with a few tiny quinquelocular pores, all of one size, between each spiracle and the body margin, and around the anal plates; dorsally, just behind the conical apex of the body, with a pair of large somewhat quadrate compound cribriform plates; submarginal tubercles apparently wanting; anal plates small, short triangular, the inner face of each from a little anterior to the middle to the apex with five large "pores," presumably the insertions for short spines, with a similar pore dorsally about a third

of the plate length from the posterior end, the presence or absence of ventral fringe or hypopygial setae not determinable; anal ring

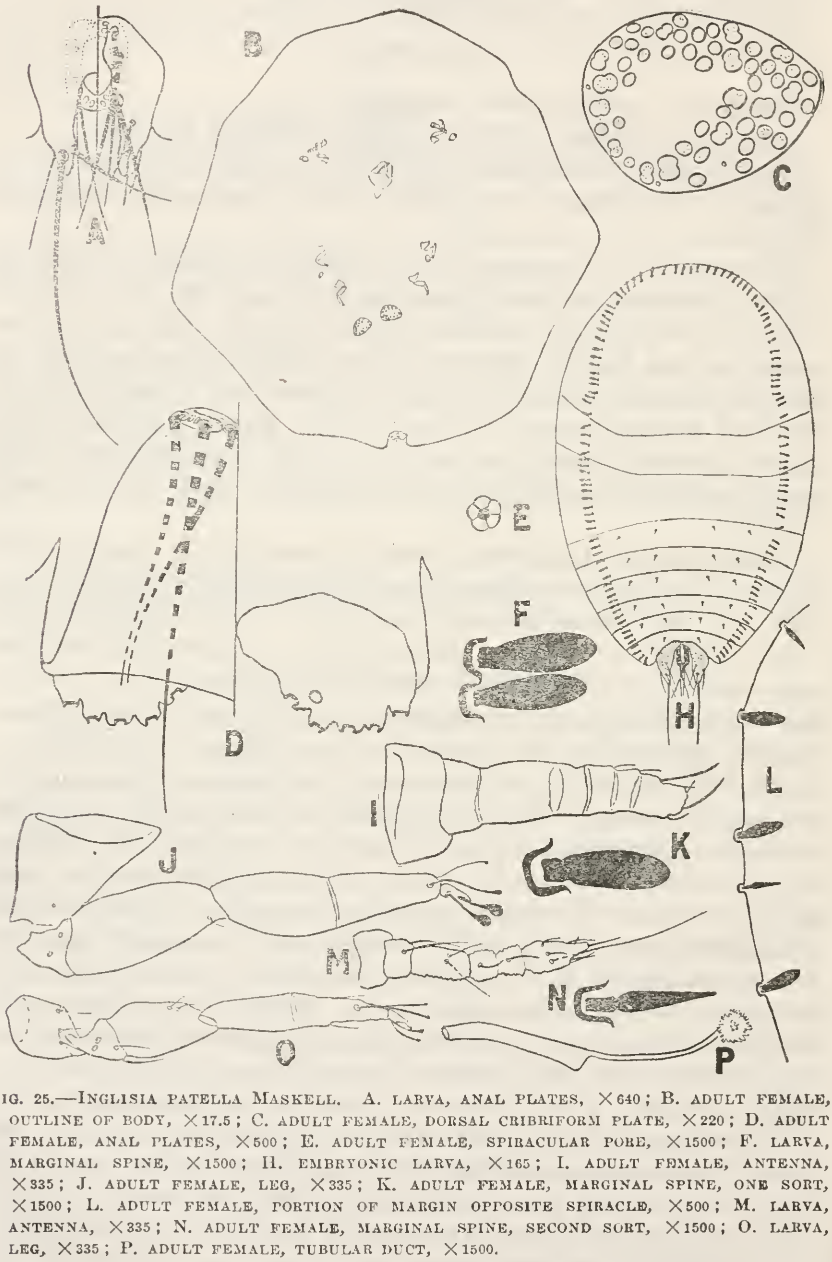

FIG. 25.—INGLISIA PATELLA MASKELL. A. LARVA, ANAL PLATES, ×640; B. ADULT FEMALE, OUTLINE OF BODY, ×17.5; C. ADULT FEMALE, DORSAL CRIBRIFORM PLATE, ×220; D. ADULT FEMALE, ANAL PLATES, ×500; E. ADULT FEMALE, SPIRACULAR PORE, ×1500; F. LARVA, MARGINAL SPINE, ×1500; H. EMBRYONIC LARVA, ×165; I. ADULT FEMALE, ANTENNA, ×335; J. ADULT FEMALE, LEG, ×335; K. ADULT FEMALE, MARGINAL SPINE, ONE SORT, ×1500; L. ADULT FEMALE, PORTION OF MARGIN OPPOSITE SPIRACLE, ×500; M. LARVA, ANTENNA, ×335; N. ADULT FEMALE, MARGINAL SPINE, SECOND SORT, ×1500; O. LARVA, LEG, ×335; P. ADULT FEMALE, TUBULAR DUCT, ×1500.

relatively large, placed a little before the plates, with pores and six setae—not eight.

Intermediate stages.—Not available.

Larva (embryonic).—Elongate oval, antennae 6-segmented, legs normal, claw with denticle, digitules slender, one tarsal longer and larger than the other, inserted above it, one of the claw similarly enlarged; mentum very short, 1-segmented; body margin with a continuous closely set row of clavate spines, some slightly smaller than others, accompanied above and below by more widely separated tiny submarginal setae; with a pair of long slender hairs ventrally anterior to the anal ring; body apparently without gland pores; anal plates slender, tapering, with a long apical seta and six other slender setae; anal ring small, with pores and six setae.

Cotype.—Cat. No. 24771, U.S.N.M.

Eleven species besides the type have been included in this genus by various writers. After an examination of specimens or descriptions of all of these, the conclusion that no one of them is congeneric with the type is unavoidable. The peculiar character of the marginal spines and the complete lack of differentiation of the spiracular spines in both adult and larva, and the development of the unusual compound cribriform plates in the adult all serve to separate the type species sharply and widely from the other species included in the genus, and similarly from the other species and genera of the group in which the genus has been placed, in so far as the latter are known to the writers.

The following generic diagnosis is therefore confined to the type species.

GENERIC DIAGNOSIS OF INGLISIA.

Coccine forms (of Fernald Catalogue) covered, in the older stages at least, by a glassy, vertically striated test or shell, conical in the type; body of adult female delicate, convex above, short and the margin angular, anal cleft very short, antennae indistinctly 7-segmented, legs normal, mentum 1-segmented, marginal spines of two sorts, tapering and slender, and stout clavate, alternating, spiracular spines not differentiated, dorsal and ventral setae present, mostly very few and scattered, with only long tubular ducts and small quinquelocular disk pores (ventral), anal plates small, triangular, with several stout setae along inner margin of each, anal ring with pores and six setae; larva elongate oval, antennae 6-segmented, legs normal, body margin with continuous series of closely set clavate spines, spiracular spines not differentiated, anal plates slender, tapering, with long apical seta and several others, anal ring with pores and six setae.

Some of the structural characters of this genus suggest a relationship to the subfamily Asterolecaninae, notably the dorsal cribriform plates, the peculiarly shaped anal plates, and the glassy external covering, but other characters do not bear out this suggested rela-

tionship, so the genus appears actually to be rather anomalous among the Coccinae and may stand alone as a distinct tribe when the generic classification of this subfamily is reorganized.

Genus PARALECANIUM Cockerell.

Plate 4, fig. 5.

Genotype.—*Lecanium frenchii* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 199.

The type of this genus was specifically designated as being *Lecanium frenchii* Maskell at the time Professor Cockerell erected the subgenus *Paralecanium*, which he later raised to generic standing.

The Maskell collection includes three slides of the type species, one of "adult female, Aug. 1890," one of "antenna of female, Aug., 1890," and one of "2nd stage female, Aug., 1890," besides which there are a few unmounted specimens under No. 131.

Adult female.—Flat, broad oval, dorsal derm heavily chitinized, dark brown; derm clearing only a little when boiled in potassium hydroxide; body with clear radial lines extending part way in toward the center all the way around the margin, these continued as large areolations in the middorsal region; antennae small, slender, 8-segmented; legs small, slender, normal, claw apparently without denticle, digitules slender, knobbed at apex; spiracles small, slender in middle; mentum small, short, 1-segmented; marginal flabella small, faintly striate, triangular with rounded corners, not overlapping; spiracular spines in threes, the middle one somewhat longer, all slightly clavate; dorsal surface with an occasional small slender hair, ventral surface with two pairs of relatively large setae anterior to the anal ring, and with scattered minute setae; derm with occasional clear pores through the chitin dorsally, probably representing the openings of tubular ducts, although details of such can not be made out, ventrally with a row of tiny quinquelocular pores between each spiracle and its marginal spines, similar pores in all probability present in the ventral anal region, although here again they are not observable; anal plates elongate, triangular, posterio-lateral margin somewhat longer than anterio-lateral; anal plate setae very few, only a single submedian one observed dorsally, apparently without apical setae, and with only a single fringe seta ventrally, these very small, and possibly with a few more present; anal ring small, stout, normally placed anterior to the plates, with pores and six long setae.

Intermediate stages.—None available for examination. (Maskell's 2nd stage female apparently a late first stage larva.)

Larva.—(Maskell's 2nd stage female.) Only one specimen badly attacked by fungus, so that nearly all the characters are obscured, those visible shown in figure.

Cotype.—Cat. No. 24772, U. S. N. M.

Between fifteen and twenty species and varieties besides the type have been placed in this genus, all of which, with the possible exception of *P. marianum* Cockerell appear to be correctly placed. Nearly all the published work on the included species has been done by Mr. E. E. Green.[14]

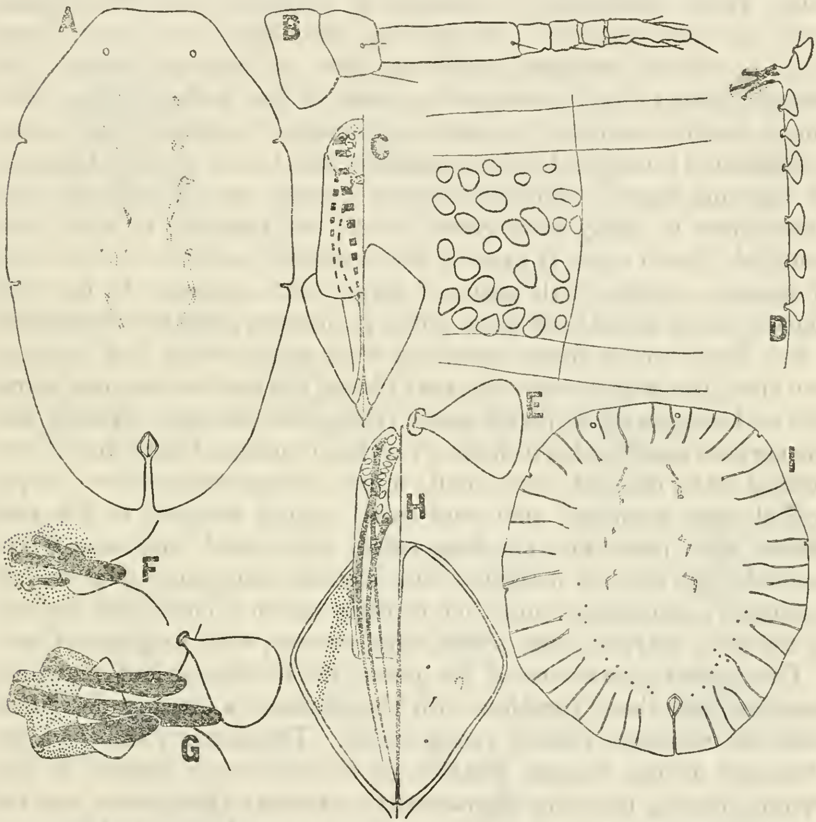

FIG. 26.—PARALECANIUM FRENCHII (MASKELL). A. LATE LARVA, OUTLINE OF BODY, ×165; B. ADULT FEMALE, ANTENNA, ×220; C. LATE LARVA, ANAL PLATES, ×220; D. ADULT FEMALE, PORTION OF BODY MARGIN, ×165; E. ADULT FEMALE, MARGINAL FLABELLA, ×640; F. LATE LARVA, SPIRACULAR SPINES, ×640; G. ADULT FEMALE, SPIRACULAR SPINES, ×640; H. ADULT FEMALE, ANAL PLATES, ×220; I. ADULT FEMALE, OUTLINE OF BODY FROM ABOVE, ×17.5.

In the following generic diagnosis an attempt has been made to cover all of the included species, with the single exception noted above.

GENERIC DIAGNOSIS OF PARALECANIUM.

Coccine forms (of the Fernald Catalogue), normally leaf inhabiting; adult female with body flat, circular to oval, medium in

[14] Chiefly in his Coccidae of Ceylon (pt. 3, 1904, pp. 235–247).

size, covered by a thin film of transparent wax, usually with margin indented at anal cleft and opposite spiracles, the cleft short, derm heavily chitinized at maturity, usually some shade of brown, at least after death, derm usually with large quadrate or polygonal depressed areas in rows in the middorsal area, with numerous large faint areolations in groups or clusters, with the dorsum more or less distinctly divided up into plates by clear lines, with a ventral marginal chitinous zone of varying width; antennae present, well developed or more or less reduced; legs present, reduced or wanting; spiracles not unusual; mentum short, stout, 1-segmented; marginal spines enlarged into broad, flattened flabella of varying shapes; spiracular spines present, set in incisions with from three to many to a group, stout, not tapering to apex, tips rounded; dorsal setae, if present, few, scattered, minute; ventral setae, if present, similar with pairs of larger setae anterior to the anal plates; dorsal specialized derm pores, if present, probably confined to a few long tubular ducts, ventrally with multilocular disk pores of two sizes, the larger below the anal plates, the smaller between spiracles and margin; anal plates small, triangular, the sides straight and the corners usually sharp, with a varying number of both dorsal and ventral setae, these all very small; minute fringe setae present, hypopygial setae wanting; anal ring small, placed anterior to the anal plates, with pores and six long setae; larva oval, antennae 6-segmented; legs normal, marginal setae slender, individual setae widely separated; spiracular spines one to three set on a chitinized incision of the body margin; anal plates long, slender, with long apical seta.

The salient characters of the genus lie in the curious marginal flabellae, and these, together with the characters already described, make its members readily recognizable. The genus *Platylecanium* Cockerell is the nearest relative of *Paralecanium* known to the writers, having the same characteristic external appearance, but the marginal spines slender, seta-like, and not expanded into flabellae.

Genus CRYPTES Cockerell and Parrott.

Plate 5, fig. 1.

Genotype.—Lecanium baccatum Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 209.

This genus, which is credited to "Crawford" in the Fernald Catalogue, is a parallel case to that of *Erium* in so far as the proper assignment of an author name is concerned. Crawford merely used the name as a specimen label in his collection; Maskell simply records the fact that Crawford did this, and goes further, in describing the species as a *Lecanium*, and shows his own conviction that the new generic name used by Crawford is not necessary. The first definite

use of the name as a unit in the classification of the Coccidae is by Cockerell and Parrott.[15]

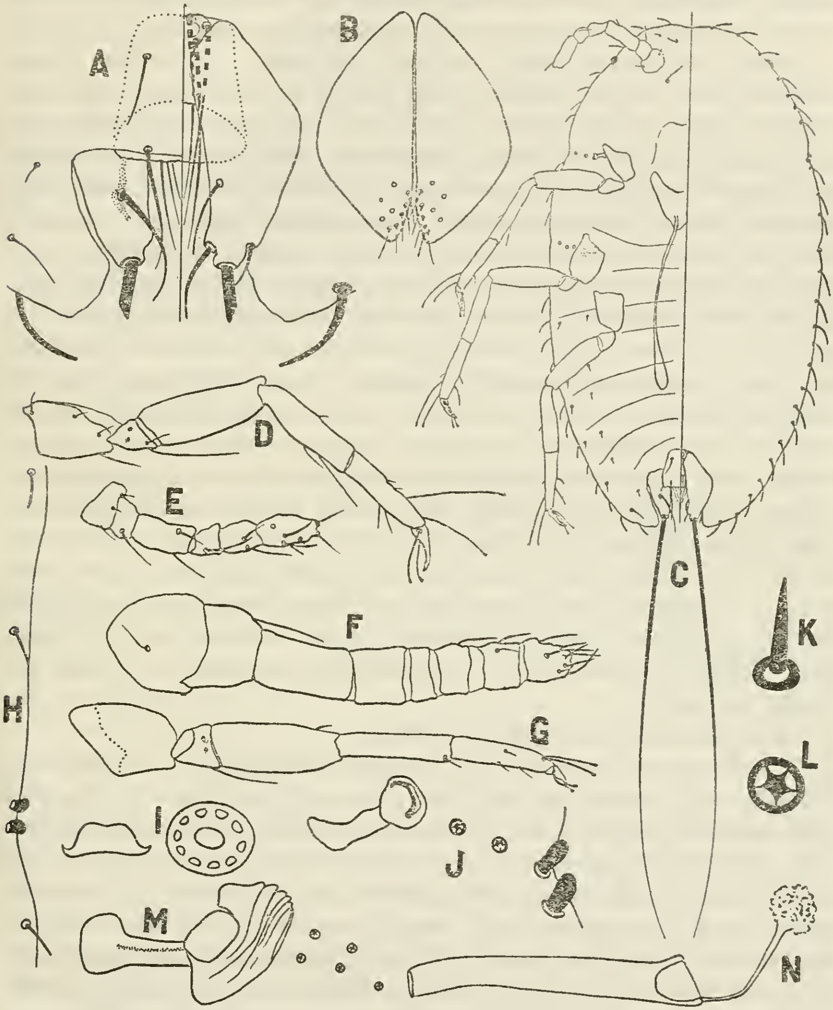

FIG. 27.—CRYPTES BACCATUS (MASKELL). A. LARVA, ANAL PLATES, ×440; B. ADULT FEMALE, ANAL PLATES, ×165; C. LARVA, OUTLINE OF BODY, ×115; D. LARVA, MIDDLE LEG, ×220; E. LARVA, ANTENNA, ×220; F. ADULT FEMALE, ANTENNA, ×220; G. ADULT FEMALE, LEG, ×115; H. ADULT FEMALE, SPIRACULAR SPINE REGION, ×220; I. ADULT FEMALE, ABDOMINAL VENTRAL DISK PORE, ×1500; J. LARVA, SPIRACLE TO MARGIN, ×640; K. ADULT FEMALE, BODY SPINE, ×1500; L. ADULT FEMALE, SPIRACULAR PORE, ×1500; M. ADULT FEMALE, SPIRACLE WITH PORES, ×220; N. ADULT FEMALE, TUBULAR DUCT, ×1500.

The Maskell collection contains two slides of this species, one of "rostrum, antenna, and foot of female, Australia, 1891," and one of "larvae, 1891." There is also a considerable quantity of unmounted

[15] The Industrialist, 1899, p. 162.

material, evidently from different collections, bearing No. 64, and from the latter it has been possible to obtain additional mounts for study, although it has not been possible to determine with certainty which unmounted lot of material represents the type lot.

Adult female.—Strongly convex, globular, or, when closely crowded, even higher, usually pale yellow in color, anal cleft completely fused, the anal plates placed in a slightly chitinized plate high up on the posterior face of the body; derm clearing completely in younger specimens, more or less chitinized in the older, more fully matured forms; antennae small, 8-segmented; legs small, slender, normal, all digitules slender and knobbed at apices, claw with denticle; spiracles normal; mentum short, 1-segmented; marginal setae small, entire, scattered, not in a distinct row; spiracular spines very stout, short, blunt tipped, normally with two opposite each anterior and one opposite each posterior spiracle; derm with occasional tiny setae, especially beneath; dorsally with an occasional long tubular duct with threadlike continuation, ventrally with small quinquelocular disk pores between spiracles and margin and numerous much larger multilocular pores over the ventral surface of the abdomen; anal plates half oval, outer angle rounded off, the ends pointed, with about four dorsal setae, near posterior apex, and one apical seta, ventral ridge with five large setae; no fringe setae as such noted; no hypopygial setae; anal ring placed below and within the plates, small, oval, apparently without pores, but with numerous (about 16) closely set setae.

Intermediate stages.—Not recognized.

Larva.—Body elongate oval; antennae 6-segmented, slender; legs slender, long, normal, all digitules slender. threadlike with knobbed tips, one tarsal digitule smaller than the other and inserted above it, claw with denticle at apex; body margin with a series of rather long setae, blunt-tipped and mostly bent or curved backwards; spiracular spines very short, stout, and bluntly rounded, normally with two opposite each anterior spiracle and one opposite each posterior, rarely with two opposite the latter; without dorsal setae or pores; ventrally with two submarginal rows of small setae on each side, paralleling the marginal, of which the setae of the outer row are about twice the length of those of the inner row; derm pores confined to the small quinqueloculars, in rows of from two to four, between the spiracles and the margin; anal plates half oval, pointed posteriorly, with a long apical seta as much as two-thirds the body length, but usually broken off more or less; with two subapical and one dorsal tetae, with one ventral ridge seta; apparently with one fringe seta; hypopygial setae wanting; anal ring small, placed just below the anterior end of the plates, with six setae.

Cotype.—Cat. No. 24773, U.S.N.M.

Besides the type species, a variety has been described by Fuller, but the writers are able to contribute nothing regarding the latter. The following generic diagnosis has been based to the description of the type species.

GENERIC DIAGNOSIS OF CRYPTES.

Coccine forms (of the Fernald Catalogue), adult female naked, globular, with anal cleft completely fused, antennae 8-segmented, legs, spiracles and mentum normal, the latter 1-segmented, marginal setae small, tapering, irregularly arranged, spiracular spines very short, stout, and blunt, not more than two opposite any spiracle, dorsal body setae few and scattered, derm pores confined to long tubular ducts and multilocular disk pores of two sizes, anal plates half oval with large dorsal, subapical and apical and ventral ridge setae, no fringe setae, no hypopygial setae, anal ring located below and within anal plates, small, oval, with numerous (about 16) setae; larva elongate, antennae 6-segmented, legs, mentum and spiracles normal, marginal setae large, blunt-tipped, curved or bent backwards, spiracular spines stout, very short, blunt-tipped, two opposite anterior, normally one opposite posterior spiracles, anal plates with very long apical setae and large dorsal, subapical and ventral ridge setae, no hypopygial setae, anal ring with six setae.

The form of the male pupa case and the structural characters of the female and larva as given above are quite sufficient to isolate this species generically, and the male pupa case, as described and figured by Maskell and commented on by Cockerell, at least indicates the possibility that *C. baccatus* digresses widely from the normal Coccine type. To the best of the writer's belief, *Kermes acaciae* Maskell represents a mixture of this species and of some species of *Eriococcus*, the immature stages, as described by Maskell being of the larva and adult of the *Eriococcus*, while the adult of Maskell is the adult of *Cryptes baccatus*. In view of the known host habits of *Kermes*, this is a logical expectation, and the writers propose the synonomy indicated, subject to future revision.

Genus ALECANOPSIS Cockerell.

Plate 5, fig. 2.

Genotype.—*Lecanopsis filicum* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 211.

This genus has never included more than the single, type species.

The Maskell collection of Coccidae contains a single unmounted specimen bearing the No. 300, and two slides, one of "adult female, 1893," and one of "antennae of female, 1893." The United States

Bureau of Entomology collection possesses a few specimens taken from the roots of grass, Yorke Peninsula, South Australia, collected by A. Koebele, which from a careful comparison with Maskell's specimens appear to be the same species, and owing to the unsatisfactory condition of Maskell's mounts, some of the description and the figures given below have necessarily been taken from the South Australian specimens.

Adult female.—Body strongly convex, wrinkled, dark reddish brown, etc., as described by Maskell; derm clearing after treatment with potassium hydroxide; antennae small and short, 6-segmented; legs much reduced, semi-rudimentary, the joints very indistinct, the claw stout and short, both pairs of digitules present, slender, knobbed; spiracles large, stout and heavily chitinized, considerably more developed than in the normal coccine forms; mentum very

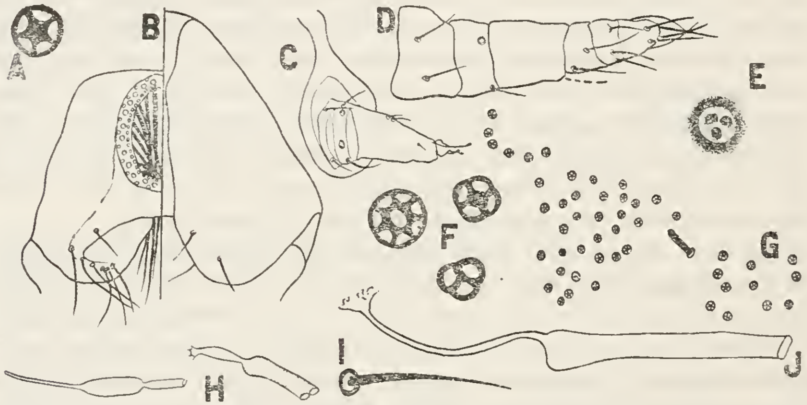

FIG. 28.—ALECANOPSIS FILICUM (MASKELL), ADULT FEMALE. A. SPIRACULAR DISK PORE, ×1500; B. ANAL PLATES, ×165; C. LEG, ×220; D. ANTENNA, ×220; E. DERM PORE ABOVE ANAL PLATES, ×1500; F. VENTRAL ABDOMINAL MULTILOCULAR DISK PORES, ×1500; G. SPIRACULAR SPINE AND ADJACENT PORES, ×165; H. SMALL TUBULAR DUCTS, ×1500; I. DERM SETA, ×500; J. LARGE TUBULAR DUCT, ×1500.

short and broad, small, 1-segmented; derm with tubular ducts, large and small, scattered rather uniformly throughout, and ventrally with multilocular disk pores, all of approximately one size, normally with about seven loculi, but variable, as shown in figure, in transverse rows anterior to the anal plates, with pores of similar size, but normally quinquelocular, in rather heavy bands between the spiracles and the margin, dorsally anterior to the anal plates with some circular indistinctly trilocular disk pores; marginal setae stiff, tapering, entire, rather long, scattered and not in a single row in one plane and sometimes two deep, not continuous clear up to the spiracular spines; the latter short, stout, somewhat clavate, with one, or rarely

two, opposite each spiracle, placed in the midst of a group of disk pores; dorsal derm with an occasional small stiff seta, these much more numerous and larger in the area around the anal plates, ventral derm with an occasional large stiff seta anteriorly, and a number of the same in transverse rows, one to each abdominal segment, posteriorly; anal plates stout triangular, the anterio-lateral margin longer than the posterio-lateral, the apices rounded, bearing three or four subapical and apical setae dorsally, and about five to seven larger ventral setae, mostly subapical, but probably continuous with a row of fringe setae which was not observable in the Maskell mount on account of its condition; no hypopygial setae noted; anal ring relatively large, not very heavy, with a double row of pores and numerous (perhaps as many as 24) rather long, stout setae.

Immature stages.—None available for examination.

The following generic diagnosis has been based wholly on the preceding description.

GENERIC DIAGNOSIS OF ALECANOPSIS.

Coccine forms of the Fernald catalogue, having a subterranean habit; adult female strongly convex, wrinkled, derm not heavily chitinized, antennae reduced, 6-segmented, legs much reduced, joints indistinct, mentum very short, 1-segmented, spiracles considerably larger than normal, and more heavily chitinized, derm pores including tubular ducts of two distinct sizes, somewhat variable multilocular disk pores, those opposite spiracles with five loculi, those anterior to anal plates with seven, and dorsally with obscurely trilocular disk pores anterior to anal plates, all derm setae slender, but stiff, the marginal scattered, entire, not in continuous row, the spiracular spines stout, clavate, one or two opposite each spiracle, dorsal setae small, ventral larger, but still small, anal plates broad triangular, with a few dorsal apical and subapical setae, a number of larger ventral ridge setae, and some large fringe setae, anal ring rather slender, with pores and very numerous (over 20) setae.

The writers have no specimens of *Lecanopsis* available for examination, and are therefore unable to make a critical comparison of it with *Alecanopsis*. Professor Cockerell established the genus in 1901 on the very superficial characters of the shape of the body, the color, and the reduction of the legs and antennae. This reduction, in connection with the enlargement of the spiracles, the habit and the great increase in the number of anal ring setae are probably quite sufficient to separate this genus from all of the other genera now included in the Coccinae of the Fernald catalogue.

Subfamily Diaspinae.

Genus POLIASPIS Maskell.

Plate 5, fig. 3.

Genotype.—Poliaspis media Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, p. 243.

Maskell established this genus on the basis of the type species only, although a number of additional species have been placed in it subsequently.

The species is represented in the Maskell collection by a single slide, presumably the type one, labeled "female, 2 stages from Veronica, Jan. 1879." There is also some unmounted material in the Maskell collection under No. 27, while the National Collection of Coccidae also contains some material received from Maskell through Cockerell, and supposed to be a portion of Maskell's type material. Such slides as have been prepared from this last and from Maskell's unmounted specimens appear to represent a different species from that mounted by Maskell in 1879. The following specific description has therefore been confined to the material on the type slide, and on account of its condition certain details of structure have necessarily been omitted.

Adult female.—Scale as described by Maskell: body elongate oval, tapering somewhat posteriorly, membranous, except a portion of the pygidium; antennae small, flattened tubercles with one or two long spines; spiracles slender, each accompanied by a close group of pores, the anterior with about 15–20, the posterior with about 12–15; margin of head with a few small setae; margins of thorax and abdominal segments with a few small setae and with short, small tubular ducts and slender gland spines with broadly expanded bases, these latter extending in from the margin ventrally; hind margin of posterior abdominal segments with a definite row of tubular ducts on each side and another similar row about midway between center and margin, these dorsal; pygidium not especially large nor prominent, not sharply separated from remainder of body, rounded at apex, median lobes large, not contiguous, more or less protruding, strongly diverging, the margins rounded off and finely crenulate in part, lobes joined by a heavy chitinized thickening, and with a pair of sharp, converging setae between the lobes; inner lobule of second lobes smaller, somewhat asymmetrical, the apex rounded, the outer lobule broadly triangular, inconspicuous, the two lobules of the third lobes represented only by inconspicuous marginal projections; margin beyond lobes broken, but without distinct teeth or crenulations; gland spines relatively long and slender, one outside each median lobe, one beyond the second lobes, one beyond the rudi-

ments of the third lobes, then one more near the basal angles of the pygidium; marginal setae, dorsally one anterior to outer angle of median lobe, one above outer lobule of second lobes, then two more at increasing intervals, ventrally the median pair and one approxi-

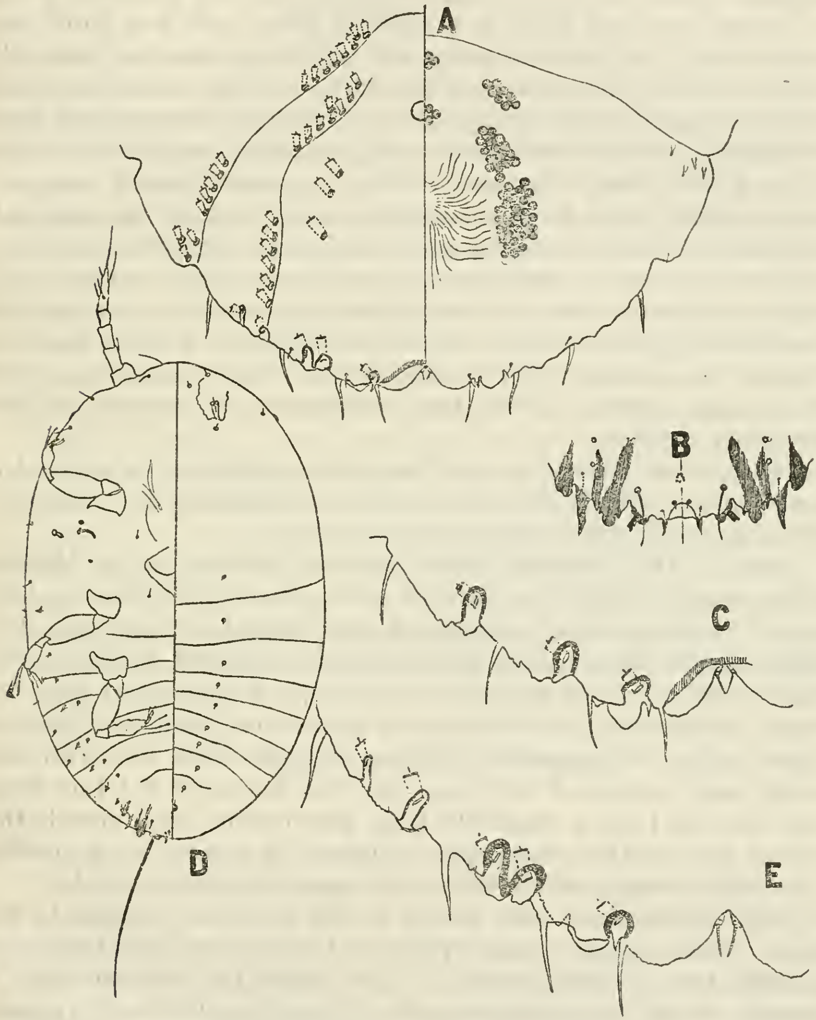

FIG. 29.—POLIASPIS MEDIA MASKELL. A. ADULT FEMALE, PYGIDIUM, ×220; B. POLIASPIS, SPECIES, LARVA, APEX OF ABDOMEN, ×500; C. POLIASPIS MEDIA, INTERMEDIATE STAGE, FEMALE, MARGIN OF PYGIDIUM, ×500; D. POLIASPIS, SPECIES, LARVA, OUTLINE OF BODY, ×230; E. POLIASPIS MEDIA, ADULT FEMALE, MARGIN OF PYGIDIUM, ×500.

mately just below each of the dorsal setae; without incisions or paraphyses; anal opening rather small, placed much nearer anterior margin of the pygidium; paragenitals in eight groups, the median 6–7, supplementary median 6–8, anterio-laterals 14–22, supplementary anterio-laterals 5–10, posterio-laterals 25–35; marginal pores

short tubular, of moderate size, one opening just inside second lobe, and with a short spinelike marginal projection opposite it, then with two in a group, one inside, one anterior to the rudimentary third lobes, and after an interval two more; dorsal pores placed in definite closely set rows, inner with three to four, posterior group of second row with about 6–8, anterior group with 5–6, third row with about 7 in posterior group and 6–7 in the anterior; ventrally with a number of micropores, the ducts of these rather short and stout, the exact number and position of these not determinable from Maskell's type slide; with two widely separated, small, dorsal setae on each side, these above and within the posterio-lateral paragenitals; ventrally with small submarginal setae opposite the marginal, and with a pair of smaller setae within and opposite each space between the anterio- and posterio-lateral paragenitals; perhaps with others anterior to these, but not definitely discernible in the material examined; pygidium, while somewhat chitinized, without basal or ventral thickenings; with faintly defined, long triangular, dorsal thickenings running in from the posterior margin opposite the first two pairs of lobes.

Intermediate stage female.—Essentially similar to the adult, differing principally in the absence of the paragenitals and in the reduced size and development of the pores, etc.

Larva.—(Of *Poliaspis*, species, but not included in the Maskell slide mount; included for the sake of the greatest possible completeness.) Oval, antennae 5-segmented, the terminal not annulate; dorsally at apex with a pair of double, heavily chitinized, tubular ducts; legs normal; apex of abdomen with a pair of long apical setae between which are a pair of triangular projections, similar in shape to gland spines, but apparently without internal ducts, and with two small setae, outside of which are two well-developed but tiny lobes and between these a relatively large gland spine, then outside the second lobe another gland spine, followed by several much smaller ones on the margin of the abdominal segments, a pair to each.

Eight species have been placed in this genus in addition to the type. These appear to the writers to belong to at least three and possibly four different groups. *P. pini* Maskell is quite obviously a member of the Lepidosaphes series. *P. carissae* Cockerell appears to have its relationships with the group represented by *Dinaspis* Leonardi. The status of *P. exocarpi* Maskell, *P. nitens* Fuller, and *P. intermedia* Fuller is more doubtful, but the writers at present consider their inclusion in this genus as open to question. It is not possible to comment definitely on *P. casuarinae* Lidgett. So far as may be determined from available material and descriptions, *P. argentosis* Brittain, *P. cycadis* Comstock, and *P. kiggelariae* Brain may be properly included with *P. media* Maskell. In examining

these species, no attention has been given to the question of possible specific synonomy.

The following generic diagnosis has been based largely on the specific description preceding.

GENERIC DIAGNOSIS OF POLIASPIS.

Diaspine forms, probably belonging in the generic group containing *Aulacaspis pentagona* (Targioni); scale of male elongate, Chionaspis-like, but without carinae; scale of female elongate pyriform, exuviae terminal; body of adult female membranous, elongate oval, antennae tiny tubercles, spiracles normal, all accompanied by a closely set cluster of pores, margins of thoracic and abdominal segments with small short tubular ducts, gland spines and tiny setae, pygidium rounded, median lobes large, more or less protruding, not contiguous, with an intermediate pair of setae, second and third lobes more or less developed, divided into two lobules where distinct, gland spines present, the posterior ones arranged singly, marginal setae normal, without incisions or chitinous thickenings, anal opening moderate, circular, nearer base than apex of pygidium, paragenitals present, in eight groups, marginal pores present, axis longitudinal, inner single, remainder in pairs, dorsal pores in distinct linear rows, split into two groups, axis longitudinal, pygidium with some indistinct thickenings running cephalad from margin, with ventral micropores and both dorsal and ventral setae; intermediate female in general similar to adult, but without paragenitals and less developed; young larva oval, with 5-segmented antennae, a pair of large cephalic tubular ducts, apex of abdomen with long setae, two pairs of lobes and gland spines.

Genus PHAULASPIS Leonardi.

Plate 5, fig. 4.

Genotype.—*Aspidiotus hakeae* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, pp. 251, 260.

Leonardi first established the genus *Phaulaspis* in 1897, designating *hakeae* as the type. Later, in 1900, he substituted *Cryptaonidia*, with the same type, for *Phaulaspis*, but without an explanation of his action. There appears to be no question but that the first name has precedence over the later one.

The Maskell collection contains eight slides of this species, two of "adult female, 1895," one of "male, 1895," one of "male pupa, 1895," one of "larva, 1895," one of "1st pellicle ♀, 1895," one of "2nd pellicle ♀, 1895," and one of "pellicles ♀ 1895." There is also some unmounted material under No. 483.

Adult female.—Scale as described by Maskell; body normally nearly circular, with the pygidium slightly protruding, often appearing oval, broader than long, due to the failure of the abdominal segments to expand during treatment; derm membranous, pygidium slightly chitinized; antennae tiny tubercles pointed at tip, but without setae; spiracles small, stout, not accompanied by pores; abdominal segments rather indistinct, with little clusters of short tubular ducts and tiny spines set in rings, beneath and at the margins of segments, the ducts more numerous; pygidium without lobes or plates, the margin somewhat undulating, with a small median ventral, marginal, chitinized thickening, this with a tiny seta on each side; dorsally with four small setae on each half of the pygidium, the first two, one anterior to the other, not far beyond the chitinous thickening, the third and fourth widely separated, and much beyond the first two, all submarginal; ventrally with the same number, but of smaller setae, and with the pair at the outer end of the row, instead of the inner; with a few scattered, tiny, tubular ducts ventrally close to the margin; paragenitals wanting; anal opening large, circular to triangular, placed rather close to the posterior apex of the pygidium, with distinct internal tube; apparently without dorsal setae or pores; ventrally with a single seta on each side anterior to and diagonally outside of the anal ring and three more in a group in the same direction near the anterior edge of the pygidium; nearly all of the posterior margin of the pygidium broadly but faintly thickened.

Intermediate stage female.—Cast skin large, very convex, covering the adult, approximately circular, margin of pygidium of this stage with lobes and spines as shown in figure; body itself nearly circular, antennae short tubercles bearing two rounded knobs and three spines; margin of abdominal segments with a very few setae and tubular ducts; pygidium with two pairs of well-developed lobes, the median largest, protruding strongly, deeply notched at apices, with the outer tooth shorter than inner, second lobes similar in shape, but much smaller and less prominent, and with a blunt tooth beyond these, probably corresponding to third lobe; marginal setae, dorsal, one small, on outer edge of median lobe, one, large, outside of second lobe, one, large, beyond marginal tooth, and one more, large, near end of pygidium, ventral, possibly one on median lobes, one beneath and beyond each of the other three dorsal setae, all small; with an incision with more or less distinctly thickened edges between the median and second lobes and traces of another outside of the second lobes; no marginal paraphyses; anal opening median, circular, fairly close to apex of pygidium; dorsal marginal tubular pores one or two opening into first incision, two or three in the rudimentary second incision, and one beyond each of the three large dorsal marginal setae; with a micropore tube between the median lobes and another

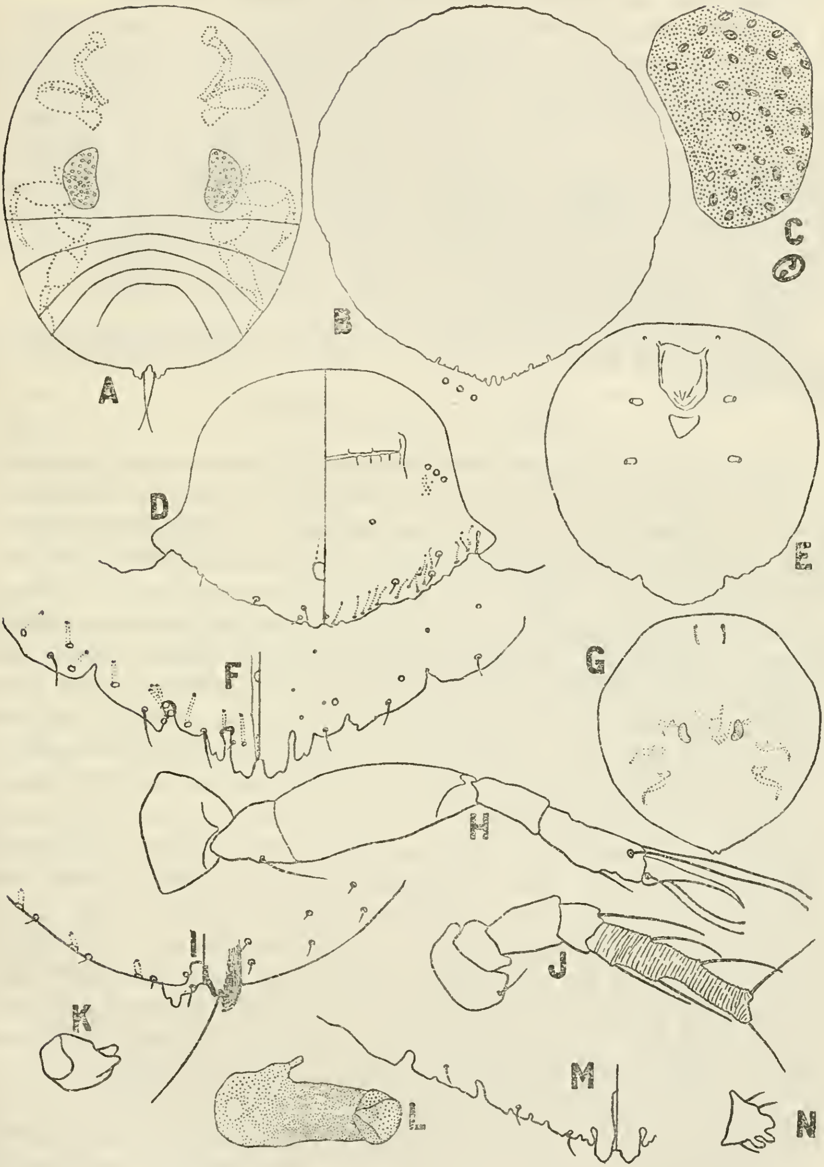

FIG. 30.—PHAULASPIS HAKEAE (MASKELL). A. LARVA, OUTLINE, ×165; B. INTERMEDIATE STAGE, CAST SKIN, ×57.5; C. LARVA, DORSAL PORE PLATE, ×640, WITH DETAIL OF ONE OF INCLUDED PORES, ×1500; D. ADULT FEMALE, PYGIDIUM, ×220; E. ADULT FEMALE, OUTLINE, ×57.5; F. INTERMEDIATE STAGE FEMALE, APEX OF PYGIDIUM, ×335; G. LARVA, CAST SKIN, ×57.5; H. LARVA, LEG, ×640; I. APEX OF LARVA, ×335; J. LARVA, ANTENNA, ×640; K. ADULT FEMALE, ANTENNA, ×640; L. SAME, SPIRACLE, ×640; M. INTERMEDIATE STAGE FEMALE, MARGIN OF PYGIDIUM OF CAST SKIN, ×220; N. INTERMEDIATE STAGE FEMALE, ANTENNA, ×640.

opening on each median lobe; with long but indistinct thickenings running from the median lobes far past the anal opening.

Larva.—Cast skin nearly circular, slightly narrowed behind, showing the two pore plates near center of body, and the remains of the appendages; embryonic larva broad oval, antennae 5-segmented, the last very long, legs slender; with a pair of large poriferous plates in the mid-dorsal region, these with a few tubular ducts and numerous S-shaped center pores; margin of body with tubular ducts and tiny setae; pygidium with anal opening close to apex; a median chitinized notch, long apical setae, then the median lobes, well developed and notched, and outside of these a few setae and tubular ducts.

Cotype.—Cat. No. 24774, U.S.N.M.

The following generic diagnosis is based on the preceding species description:

GENERIC DIAGNOSIS OF PHAULASPIS.

Diaspine forms, probably related to the *Aspidiotus* series, the adult female covered by and more or less enclosed within the convex cast skin of the preceding stage, the secretionary covering thin, usually destroyed, body circular, membranous, pygidium slightly chitinized, antennae tubercles without any long setae, spiracles small, without pores, with small clusters of short tubular ducts and tiny spines along margin of abdomen, pygidium without lobes or plates, margin undulating, with a few tiny marginal and submarginal setae, with some small tubular ducts at margin, anal opening large, with internal tube, placed near apex, paragenitals wanting, dorsal pores wanting; intermediate stage female puparium strongly convex, reddish brown, circular, body circular, antennae longer than in adult, with setae, abdominal segments with a few setae and pores at margin, pygidium with two pairs of lobes, *Diaspidiotus*-like, no plates, dorsal and ventral spines, more or less developed marginal incisions with thickened edges, no paraphyses, anal opening near apex, with dorsal marginal pores, a few micropores; larva broad oval, developed within the body of the adult, antennae 5-segmented, terminal annulate, legs long, slender, normal, with a pair of large chitinized poriferous plates dorsally near mouthparts, each bearing two types of pores, pygidium with anal opening close to apex, median chitinized notch, long apical setae, one pair of lobes and a few setae and tubular ducts.

According to the Fernald catalogue, this genus is synonymous with *Aspidiotus*, and its identity with *Anonidia* has also been suggested. It is the present view of the writers, after a rather limited study of supposedly related species, that the genus *Phaulaspis* is valid, and is entitled to generic rank, this view being largely based on the, apparently, unique development of the large dorsal poriferous areas in the larva, and on the absence of marginal pygidial plates in

all stages. No other species deserving inclusion here are known to the writers.

Genus CHENTRASPIS Leonardi.

Genotype.—Aspidiotus unilobis Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, pp. 251, 280.

This is another genus which was established with only a single included species, so that only it can be the type.

The Maskell collection contains a single slide of this species, labeled "adult female, 1894," and a small amount of material under No. 419.

Adult female.—Scale as described by Maskell and Leonardi; body nearly circular, the posterior apex slightly protruding and pointed; derm anterior to pygidium wholly membranous, the thoracic and abdominal segmentation indistinct; antennae tiny tubercles, each bearing a long stout seta; spiracles small, without pores; margins of head, thoracic and abdominal segments, both dorsally and ventrally with little groups of two or more relatively long slender setae and, usually, one or more tiny tubular ducts; posterior abdominal segments with a longitudinal row of tiny setae and a row of large tubular ducts on each half dorsally, ventrally at margin with a number of small tubular ducts on each side, with more of these in submarginal areas and with two more or less distinct longitudinal rows of tiny setae; anterior portion of pygidium hyaline, central portion more or less chitinized; median lobes only present, these fused to form one lobe, with a faint median notch, and usually two lateral notches; second and third lobes represented by tiny spine-like triangles; no lateral teeth or crenulations, but the margin outside of the plates somewhat irregular; plates present, strongly branched, two outside the median lobes, then the tiny second lobe, then three more plates, then the tiny third lobe, and one to four more plates, the last two, in the latter case, simple; with three or four very short incisions in the margin, these with more or less thickened bottoms and edges; marginal setae relatively very large, as long or somewhat longer than the plates, the median pair quite stout, but becoming gradually more slender toward the outer margin of the pygidium, dorsally with one just outside the base of the median lobes, one above the tiny second lobes, one above the third lobes, one well beyond the last group of plates, and one well beyond this; ventrally with one opposite each of these except the first; without marginal chitinous paraphyses; anal opening oval, medium in size, placed fairly close to the apex of the pygidium; paragenitals wanting; dorsal marginal pores two between first and second dorsal spines; two, separated, between second and third spines; two, well separated, between third and fourth spines; two, widely separated, between fourth and fifth spines; dorsal pores all near margin, about six in number; ventrally with a number of

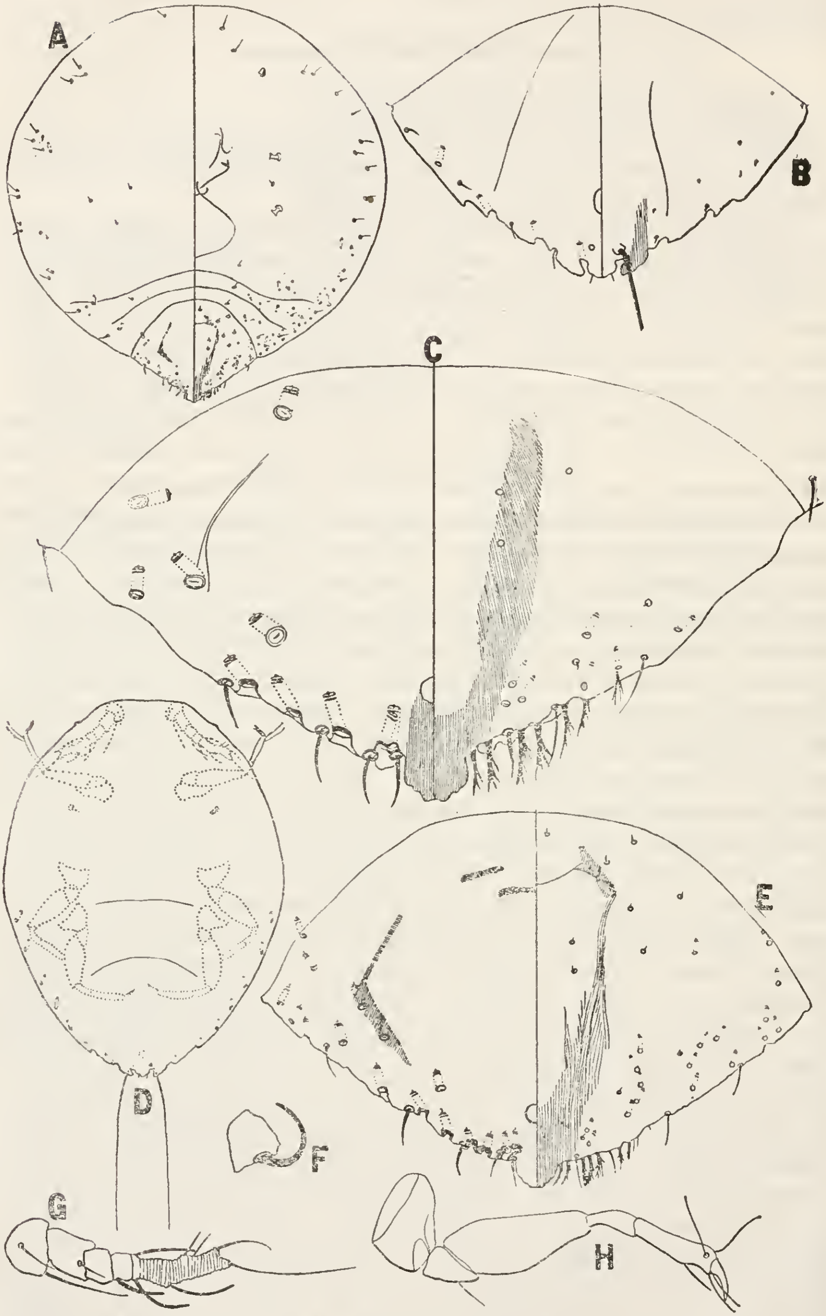

FIG. 31.—CHENTRASPIS UNILOBIS (MASKELL). A. ADULT FEMALE, OUTLINE OF BODY, ×57.5; B. LARVA, PYGIDIUM, ×500; C. INTERMEDIATE STAGE FEMALE, ×440; D. LARVA, OUTLINE OF BODY, ×220; E. ADULT FEMALE, PYGIDIUM, ×220; F. ADULT FEMALE, ANTENNA, ×640; G. LARVA, ANTENNA, ×640; H. LARVA, LEG, ×640.

submarginal micropores, two between two ventral spines, 3–5 between the second and third ventral spines, and about four or five between the third and fourth ventral spines; without setae dorsally; with a submarginal row of four small ventral setae and with about five more on each half of the anterior median portion of the pygidium; with three transverse linear basal thickenings, one median, and with one long, somewhat indistinct thickening running from the median plates out and back past these transverse thickenings.

Intermediate stage female.—Body differing from that of adult only in the smaller size and in the reduced numerical development of the pores and setae.

Larva.—Broad oval, somewhat more pointed behind; antennae slender, 5-segmented, terminal annulate; legs slender, normal, spiracles small, slender, without pores, pygidium more or less developed, margin with a median quadrate protuberance bearing two tiny setae, outside this with an incision with a tubular duct, then with the median lobe, the outer margin curved and crenulate, then a seta, followed by an incision with pore, and beyond this a succession of setae and pores; ventrally below the first incision with the long apical seta about a third the body length; anal opening medium, oval, near apex of abdomen.

Cotype.—Cat. No. 24775, U.S.N.M.

Besides the type, one other species, *Aspidiotus extensus* Maskell, was subsequently included in the genus by Leonardi. This species certainly can not be looked upon as being congeneric with the type. The generic diagnosis which follows has been based on the type species only.

GENERIC DIAGNOSIS OF CHENTRASPIS.

Diaspine forms, probably more closely related to the group containing *Aspidiotus camelliae* Signoret (*rapax* Comstock) than to any other; adult female with body nearly circular, derm membranous, antennae tiny with a single long seta, spiracles small, without pores, margin of body with some setae and small tubular ducts in clusters, pygidium somewhat chitinized, median lobes only well developed, protruding, fused into a single lobe, marginal plates present, grouped near the middle line, strongly branched, both dorsal and ventral marginal setae present, relatively large and long, with marginal incisions with thickened edges, no paraphyses, anal opening medium in size, placed near the apex of pygidium, paragenitals wanting, dorsal marginal pores present, some opening in incisions. dorsal pores present, few in number, tubes short, axis transverse, with ventral micropores with short tubes and with tiny ventral setae, with basal thickenings; intermediate stage female similar to adult, differing only in smaller size and numerical reduction of ducts and

setae; larva oval, antennae 5-segmented, terminal annulate, legs slender, normal, margin of body with a few ducts and setae, pygidium somewhat developed, anal ring near apex, median lobes only developed, separated by a rectangular projection bearing setae, apical setae long, no traces of plates, but with incisions and marginal ducts and setae.

This genus was placed as a synonym of *Aspidiotus* in the Fernald catalogue, and its identity with *Targionia* has been suggested. As already noted, the type species seems, except for the question of the size and the position of the anal opening and the fused median lobes, to resemble *A. camelliae* Signoret (*rapax* Comstock) quite closely. The writers prefer not to comment on the question of the zoological validity of this genus at present.

Genus AONIDIELLA Berlese and Leonardi.

Genotype.—*Aspidiotus aurantii* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, pp. 285, 287–8.

This genus was established for the single type species. The Maskell collection contains two slides marked as collected in 1877, and therefore presumably the type slides. This species has been shown to be extremely widespread and common, and has been described and illustrated with elaborate detail by Berlese,[16] because of which no attempt is made here to redescribe or figure it. The writers are not able to comment definitely on its generic validity, and have in consequence done nothing more than record its right to a place in the series of genera discussed in this paper.

The four following units have been variously designated by Leonardi, who described them, as genera or subgenera of the genus *Lepidosaphes* (*Mytilaspis*). While their standing is in most cases uncertain, they have been placed as genera in this paper.

Genus PHAULOMYTILUS Leonardi.

Plate 5, fig. 5.

Genotype.—*Mytilaspis striata* Maskell.

References.—Fernald, Cat. Cocc. World, 1903, pp. 304, 314.—Leonardi, Ann. R. Sc. sup. agr. Portici, ser. 2, vol. 5, 1904, p. 5.

This genus has never included more than the single type species.

The Maskell collection contains a single slide of "adult female, 1894" and a small quantity of unmounted material of this species, the latter bearing the No. 409.

Adult female.—Scale as described by Maskell and Leonardi; body elongate, broadest behind the middle, sides of cephalothorax tapering strongly anteriorly, this apex rounded; cephalothorax in fully ma-

[16] Riv. Path. Veg., vol. 4, 1895, pp. 125–137.

tured individuals tending towards chitinization, and becoming slightly distended and hardened; abdomen, including nearly all of

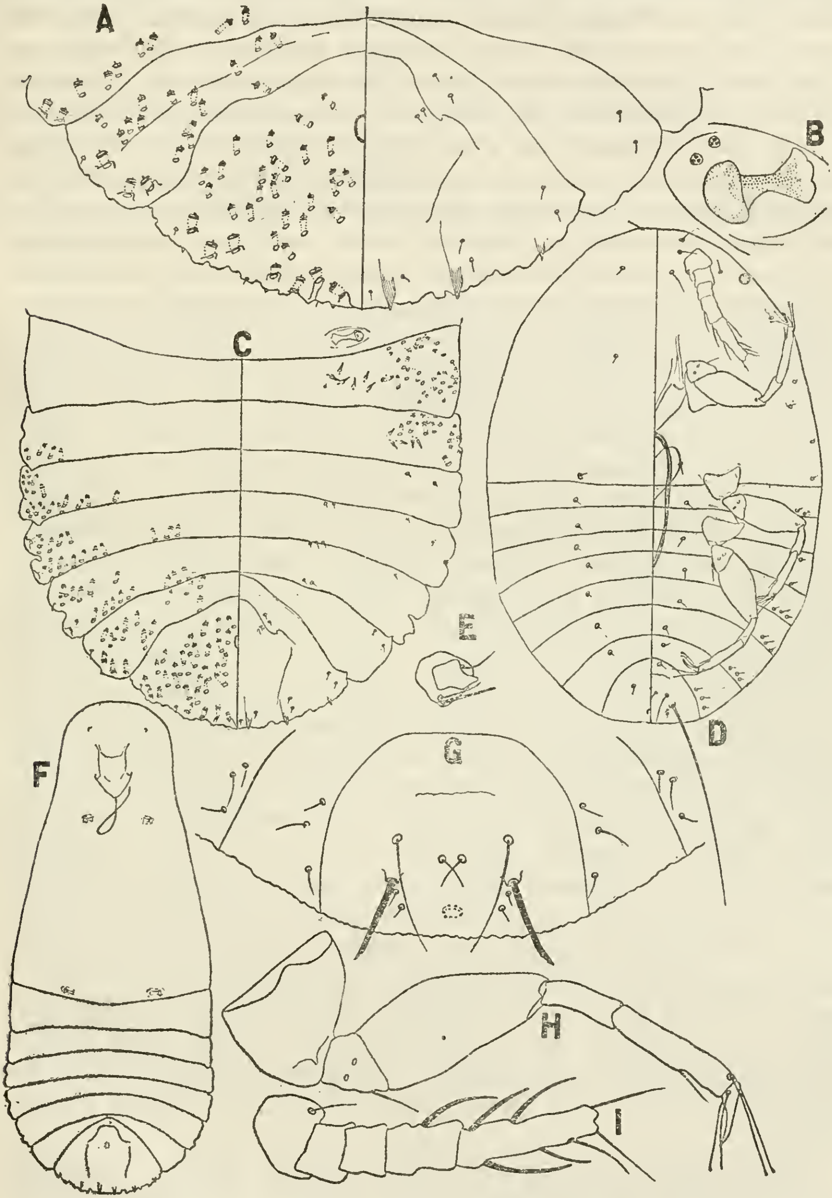

FIG. 32.—PHAULOMYTILUS STRIATUS (MASKELL). A. ADULT FEMALE, PYGIDIUM, ×220; B. ADULT FEMALE, ANTERIOR SPIRACLE, ×64; C. ADULT FEMALE, ABDOMEN, ×115; D. LARVA, OUTLINE OF BODY, ×220; E. ADULT FEMALE, ANTENNA, ×640; F. ADULT FEMALE, OUTLINE OF BODY, ×57.5; G. LARVA, APEX OF ABDOMEN, ×640; H. LARVA, MIDDLE LEG, ×640; I. LARVA, ANTENNA, ×640.

the pygidium remaining membranous, and wrinkled when dried; antennae very small tubercles bearing two medium and one longer

stout setae; spiracles small, anterior placed just behind the mouth parts, accompanied by 2–3 small disk pores, posterior placed far back, fully one-third the body length from the anterior, about the same size but without pores; eye spots represented by faint marginal protuberances a little behind the antennae; with a few tiny tubular ducts around the margin of the cephalothorax; first two abdominal segments with a considerable cluster of small tubular ducts and a few small slender gland spines with expanded bases ventrally at margin, remaining segments with similar but fewer ducts at margin and dorsally, including one or two large ducts to a segment and no gland spines; each segment ventrally with a slender submarginal seta and one or two others, smaller, inside this on each side; pygidium only faintly chitinized, lobes small, triangular, pointed, normally not or only very slightly protruding beyond the irregular margin, median lobes slightly smaller than the second pair, widely separated by a quadrate protruberance bearing two slender ventral spines at its base and having a large short-tubular duct between it and each lobe, second lobe placed well beyond the first, also triangular pointed, third still farther beyond the second, and considerably smaller; margin with a large triangular indentation beyond the third lobe; without gland spines; dorsal marginal setae, one outside of each lobe, ventral the same, and with one beyond the marginal notch, all slender, not very long; ventrally with submarginal setae, considerably larger than marginal and anterior to these, as follows: 1, 2, 2, 2; without incisions with thickened edges, but with dorsal marginal incisions into which short tubular ducts open, these ducts one inside the first lobes, two between the first and second lobes, one just inside and above the second lobe, two between the second and third lobes, one behind third lobe, and three beyond marginal notch; without chitinous paraphyses; anal opening fairly large, oval, much nearer base than apex of pygidium; paragenitals wanting; dorsal pores numerous, not arranged in definite rows of closely set pores, although in indefinite rows, about three in first, four in second, 7–8 in third, 5–7 in fourth, and about five in fifth, with some corresponding inner groups of about three each; without thickenings except those running in from the "lobes"; with a few ventral micropores and several small setae in the genital opening region.

Intermediate stage female—(From exuviae only). Apparently differing from the adult only in the reduction in size and numbers of the structures described for the latter stage.

Larva—(Embryonic). Oval, antennae 5-segmented, the fourth segment so constricted as to give somewhat the appearance of another segment; legs slender, normal, apex of abdomen not at all chitinized, with no traces of lobes or gland spines; with two long apical setae,

two very small, close together between these, one larger on each side near and below the base of the large apical seta, and two more, small, above each apical seta; each margin of each of at least the abdominal segments with three small setae, one above the other, of which the median is the longest, anal ring small, circular, somewhat invaginated, placed near the apex of the abdomen; body with dorsal and ventral rows of small setae, one on each half, as shown.

Cotype.—Cat. No. 24776, U.S.N.M.

The following generic diagnosis has been based on the preceding description.

GENERIC DIAGNOSIS OF PHAULOMYTILUS.

Diaspine forms of uncertain affinities, superficially resembling *Lepidosaphes;* the secreted covering mytilaspiform, adult female with elongate body, somewhat chitinized cephalothorax, very small antennae with three setae, spiracles with or without pores, these never numerous, abdominal segments with groups of tubular ducts and short slender gland spines with greatly enlarged bases at margins, pygidium with small triangular widely separated more or less projecting lobes, without gland spines or plates, marginal setae present, approximately normal in arrangement, without incisions with thickened edges, with slight incisions for marginal pores, without chitinized paraphyses, anal opening oval, placed much nearer base than apex of pygidium, paragenitals wanting, marginal ducts present, large, axis longitudinal or approximately so, dorsal pores present, fairly numerous, axis not uniform but approximately longitudinal, pores not arranged in definite and conspicuous rows, without internal pygidial thickenings except from base of lobes, with some ventral micropores and surface setae; intermediate stage similar to adult but less developed; larva oval, antennae 5-segmented, terminal not annulate, legs normal, apex of abdomen not chitinized, without traces of lobes or gland spines, with a pair of long apical setae and other small setae, anal ring small, circular, near apex of abdomen.

As may be noted from the preceding description, the writers consider that Leonardi's interpretation of the triangular projecting marginal structures is incorrect and that they are really poorly developed pygidial lobes, instead of gland spines. There is no evidence that they are connected with internal ducts, as are the true gland spines. The morphological modifications of the type species appear to be quite sufficient to separate the genus widely from *Lepidosaphes*, as represented by the type, *L. ulmi* (Linnaeus) and to establish it as a unit of full generic rank. The writers are not able to say whether or not the genus thus established is identical with any other described

genus, or whether it should remain in the group of species of which *Lepidosaphes* is typical.

Genus COCCOMYTILUS Leonardi.

Plate 6, fig. 1.

Genotype—Mytilaspis convexa Maskell.

References.—Fernald, Cat. Cocc. World, 1903, pp. 304, 307.—Leonardi, Ann. R. Sc. sup. agr. Portici, ser. 2, vol. 5, 1904, p. 4, 9.

Leonardi apparently failed to designate a type species for this genus, and it seems to have first been set in the Fernald catalogue.

The Maskell collection contains a single slide of "adult female, 1892" and a small quantity of unmounted material of this species, the latter under No. 347.

Adult female.—Scale as described by Maskell and Leonardi; body elongate, broadest about the middle, narrowed anteriorly; cephalothorax and anterior abdominal segments in fully matured individuals hardened, chitinized, and brittle, remainder of abdomen, except portions of the pygidium, membranous; antennae small tubercles bearing two setae of unequal length and some conical protuberances; spiracles small, anterior with 3–5 pores, posterior with 2–3 pores; head with some pairs of small setae around margin; margins of thoracic and abdominal segments with clusters of numerous tubular ducts, some ventral, some dorsal; with a cluster of conical gland spines with somewhat enlarged bases ventrally posterior to each spiracle; with similar gland spines ventrally on the second and third abdominal segments near margin; with a few marginal setae and straight, tapering gland spines on remaining segments; pygidium somewhat chitinized, the margin uniformly curved, with three pairs of lobes, all protruding, the median large, prominent, the apical border rounded and more or less distinctly notched at each side, second lobes about half as long and wide, the posterior margin nearly straight, somewhate crenulate, third lobes well beyond second, obtusely triangular, the outer face longest, margin beyond this irregularly toothed and incised developing projections resembling the third pair of lobes but not chitinized; gland spines present, two between median lobes, two between these and second lobes, first two, then one, between second and third lobes, two outside of third lobes and two more beyond two toothlike projections of the margin, all small but gradually enlarging from the median out; marginal setae present, dorsally one inside, one outside each median lobe, one outside each second and third lobe, one beyond marginal projection, ventrally one outside each median lobe, and one below and beyond each of the remaining dorsal setae, these all fairly large; no incisions with thickened edges; no chitinous paraphyses; anal opening rather small, approximately circular, placed near the base of the pygidium;

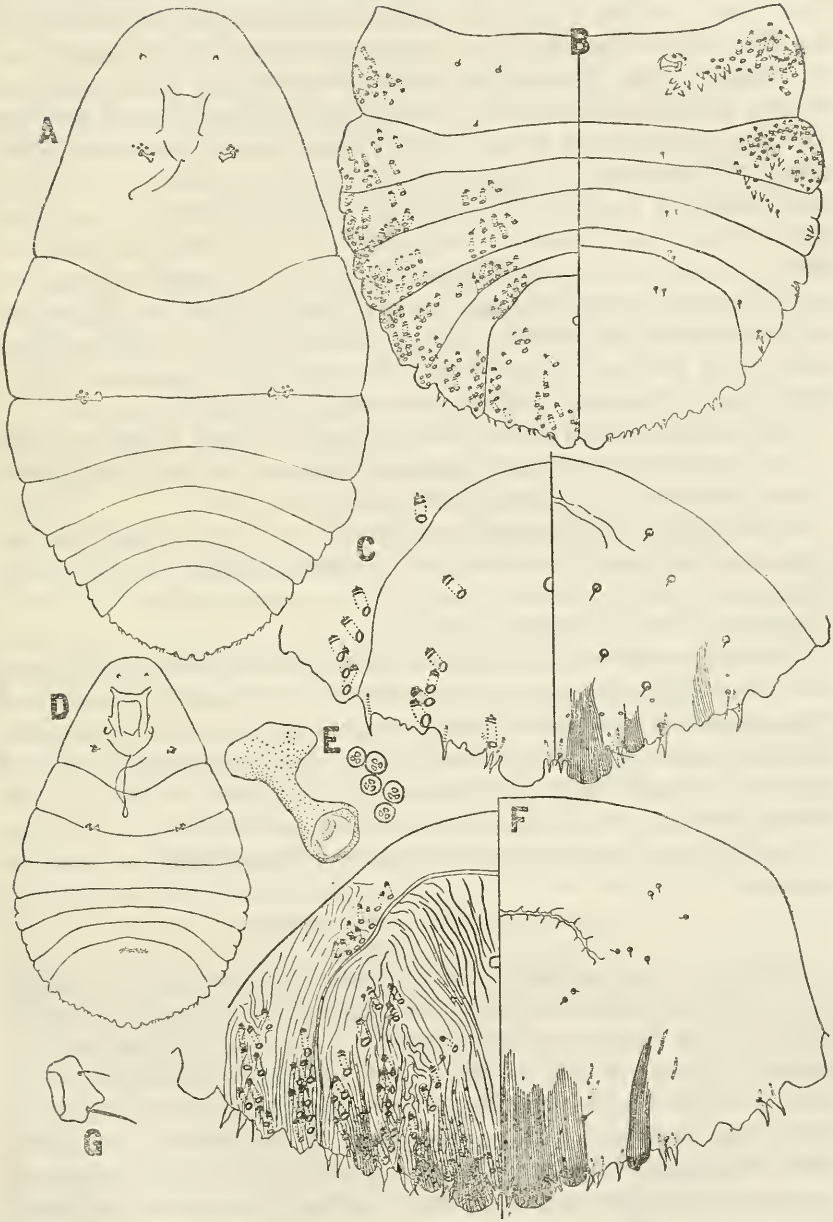

FIG. 33.—COCCOMYTILUS CONVEXUS (MASKELL). A. FULLY DISTENDED AND CHITINIZED ADULT FEMALE, ×57.5; B. ADULT FEMALE, ABDOMEN, ×115; C. INTERMEDIATE STAGE FEMALE, PYGIDIUM, ×335; D. ADULT FEMALE BEFORE DISTENSION, ×57.5; E. ADULT FEMALE, SPIRACLE, ANTERIOR, ×220; F. ADULT FEMALE, PYGIDIUM, ×220; G. ADULT FEMALE, ANTENNA, ×640.

paragenitals wanting; marginal and submarginal pores present, arranged as follows: three, one median, between median lobes, one behind each median lobe, one behind outer margin of same, two between first and second lobes, one or two behind second lobe, three, in a more or less distinct row, between second and third lobes, one behind third lobe, about five in and just anterior to both the first and second marginal teeth; dorsal pores rather numerous, indistinctly differentiated from marginal, chiefly marked by position and somewhat smaller size, arranged in fairly distinct rows, about five in inner row, three in both posterior and anterior group of next row, two in the following row, about five in posterior group and 5–7 in anterior group of next row; ventrally with a few micropores and some setae, the latter mostly around the vaginal opening; anterior to two median pairs of lobes and around anal opening slightly more heavily chitinized than in remainder of pygidium.

Intermediate stage female.—Resembling the adult, differing chiefly in the reduction in size and numerical quantity of the lobes, pores, gland spines, etc., as already described for the adult.

Larva.—Very unfortunately no larvae seem to be present in the type material, and it has not been possible to make out the larvel characters from the exuviae available for examination.

Cotype.—Cat. No. 24777, U.S.N.M.

From a comparison of the adult females of the species which have been included in this genus, the writers consider that the inclusion of *C. bambusicola* (Cockerell) and *C. argentata* (Cockerell) is probably entirely incorrect. The position of the remaining species assigned here by Leonardi appears to be debatable, and can probably not be settled until a revision of *Lepidosaphes* is undertaken.

The following generic diagnosis has been based chiefly on the type species.

GENERIC DIAGNOSIS OF COCCOMYTILUS.

Diaspine forms probably closely related to *Lepidosaphes*, apparently differing from that genus, as represented by the type species chiefly in the absence of paragenitals in the adult female, and the tendency of the anterior portion of the body to become heavily chitinized at maturity; body mytilaspiform, antennae very small tubercles with setae, spiracles with a few pores, cephalothorax with small setae, with small tubular ducts, and some gland spines, margins of abdominal segments with the same; pygidium somewhat chitinized, lobes present, gland spines present, marginal setae normal, without incisions with thickened edges or chitinous paraphyses, anal opening located near base of pygidium, small, circular to oval, paragenitals wanting, marginal pores present, axis longitudinal, dorsal pores present, fairly numerous, in rather distinct rows, axis more or less longi-

tudinal, with micropores and some setae ventrally, without internal basal thickenings; intermediate stage in general resembling adult, but less developed; larva not known.

As noted in the generic diagnosis, the chief basis for separating this genus from *Lepidosaphes* appears to lie in the absence of paragenitals, a doubtful generic character. The writers prefer not to comment definitely on the status of this genus at present.

Genus TRICHOMYTILUS Leonardi.

Plate 6, fig. 2.

Genotype.—*Mytilaspis formosa* Maskell.

References.—Fernald, Cat. Cocc. World, 1903, pp. 304, 309.—Leonardi, Ann. R. Sc. sup. agr. Portici, ser. 2, vol. 5, 1904, pp. 4, 23.

Only the single-type species has ever been included in this genus.

The Maskell collection includes two slides of this species, one of "adult females, 1893," and one of "puparia with females and male, 1893," and besides this a small quantity of unmounted material under No. 337.

Adult female.—Scale as described by Maskell and Leonardi; body mytilaspiform; antennae small, cylindrical tubercles with invaginated apices and two slender setae protruding slightly and with a stout short spine on the lip; spiracles slender, posterior without pores, anterior with two trilocular pores; head with a few small tubular ducts and setae; body segment between spiracles and that posterior to hind spiracles with a triangular cluster of small tubular ducts running from opposite the spiracle to and around each margin, and with a few conical gland spines with expanded bases at the inner apex of each, next two segments (abdominal) with similar clusters, but denser and with the gland spines more numerous, gland spines of the following abdominal segment reduced to two large, long tapering ones at margin; pygidium with three pairs of small protruding lobes, the median largest, spatulaform, with faint traces of notches on inner and outer faces, not contiguous, but united by a thickening, and with a tiny triangular tubercle just inside of each and a median pair of ventral setae, second lobes smaller and more slender than median, very faintly notched, third stouter and larger than second, usually nearly straight within and distinctly notched without, margin beyond third lobes somewhat notched; gland spines present, unusually large and long, the first three double—that is, with two ducts leading into a single spine—one present outside of each of the lobes, the fourth either double or with two separate spines, the fifth group of two spines; marginal setae, dorsally two, small, just outside of median lobes, one long, slender, anterior to both the second and third lobes, another similar, anterior to the second toothlike projection

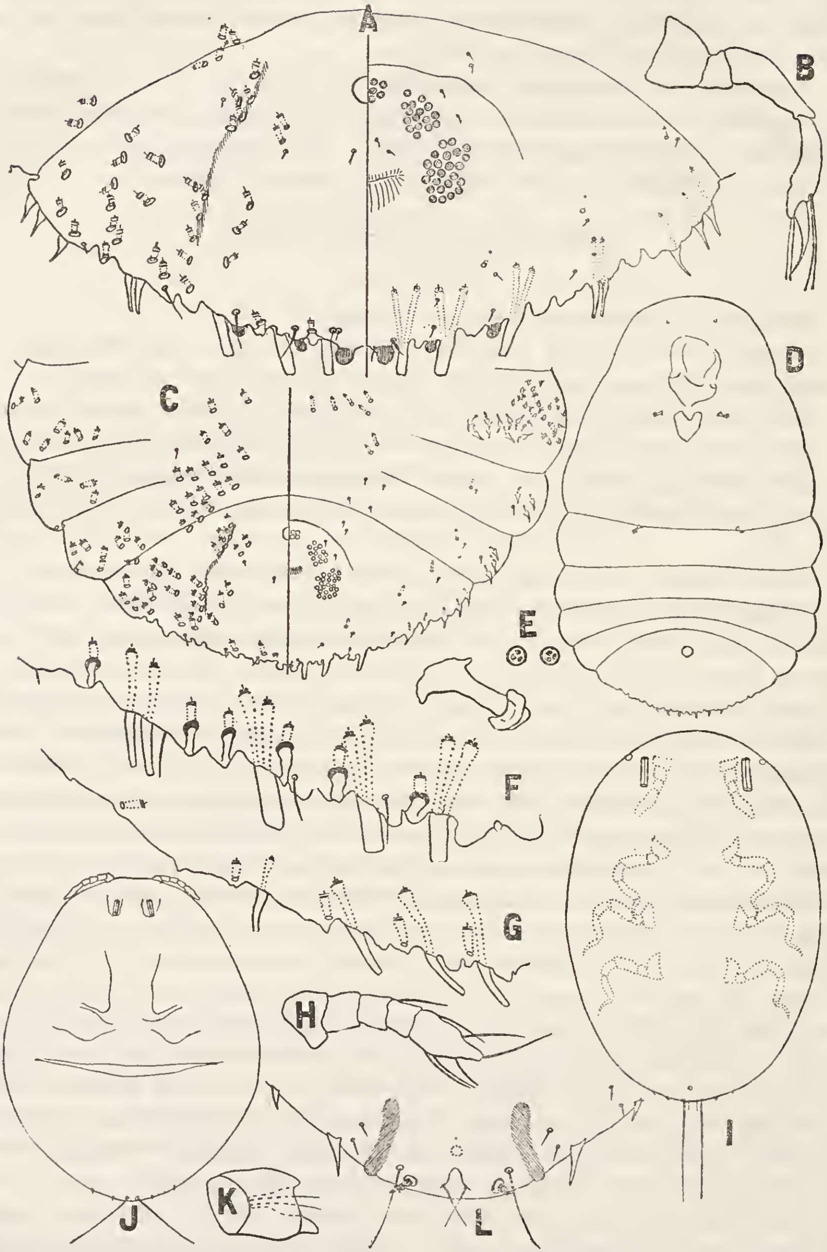

FIG. 34.—TRICHOMYTILUS FORMOSUS (MASKELL). A. ADULT FEMALE, PYGIDIUM, ×220; B. LARVA, LEG, ×640; C. ADULT FEMALE, APEX OF ABDOMEN, ×115; D. ADULT FEMALE, OUTLINE OF BODY, ×57.5; E. ADULT FEMALE, ANTERIOR SPIRACLE, ×500; F. ADULT FEMALE, MARGIN OF PYGIDIUM, ×335; G. INTERMEDIATE STAGE FEMALE, MARGIN OF PYGIDIUM, ×335; H. LARVA, ANTENNA, ×640; I. LARVA, OUTLINE OF BODY, ×220; J. LARVA, CAST SKIN. ×115; K. ADULT FEMALE, ANTENNA, ×1500; L. LARVA, APEX OF ABDOMEN, ×640.

beyond the third lobes, and still another, smaller, near the base of pygidium, ventrally with those between the median lobes, already mentioned, a small one beneath the first dorsal pair, and similar ones, all small, corresponding to the remaining dorsal setae; with a submarginal ventral row of smaller setae, each anterior to a marginal seta, except the first, and each accompanied by a micropore; without incisions with thickened edges, but with the openings of the marginal pores set in slightly, the rim chitinized and with a rather prominent lobelike marginal projection below each, these pores one inside second lobe, one inside third lobe, two between third and fourth gland spine groups and three near base of pygidium; anal opening of medium size, circular, close to base of pygidium; paragenitals present, in five groups, median 6–7, anterio-laterals 13–17, posterio-laterals 19–23 (one group with 10), these averages from four specimens; dorsal pores present, in fairly distinct rows, the pores set rather close together, inner row posterior group 1–3, anterior 2, second row, posterior group variable, 3–5, anterior 3–5, then with supplementary posterior row of two, third row, posterior group about four, anterior about four; without internal pygidial thickenings; with two pairs of tiny setae dorsally near anal opening and similar setae ventrally near the genital opening.

Intermediate stage female.—(exuvium only) apparently resembling the adult female, differing chiefly in the reduced development of the various pygidial structures and in the gland spines being single and isolated.

Larva.—Oval, antennae slender, 5-segmented; legs slender, normal, the claw long, very slender, curved; anterior apex of body with a pair of large and long slender tubular ducts; the tiny circular anal ring near body apex; apex of abdomen with long and short setae, one pair of lobes, marginal ducts and two pairs of gland spines.

Cotype.—Cat. No. 24778, U. S. N. M.

The following generic description is based on the preceding description.

GENERIC DIAGNOSIS OF TRICHOMYTILUS.

Diaspine forms, with female scale elongate, mytilaspiform, exuviae terminal, body of adult female similar, antennae cylindrical invaginated tubercles with setae, spiracles slender, with or without pores, margin of cephalothorax and abdominal segments with tubular ducts, gland spines and small setae, in rather definite arrangement, pygidium rounded, with well developed entire lobes, large and long double gland spines, normal dorsal and ventral setae at margin, no incisions with thickened edges, no paraphyses, anal opening fairly large, near base of pygidium, paragenitals present, in five groups, marginal pores present, dorsal pores present, in fairly distinct rows,

with both dorsal and ventral surface setae, with ventral micropores, without distinct internal thickenings; intermediate stage similar to adult, but less developed; young larva oval, antennae 5-segmented, legs normal, anteriorly with a pair of large tubular ducts, apex of body with a pair of large apical setae, lobes, gland spines and other smaller setae.

No other species has been included in this genus, which was based wholly on the development of a supplementary fluffy secretion covering the female scale to some extent, a character which would seem to be of very little value. In the opinion of the writers this genus should be included in the *Chionaspis* series, instead of the *Lepidosaphes* group, this view being based on the characters of the pygidium, such as the absence of a median pair of gland spines and the presence of a double pair of setae dorsally near each median lobe, and on the character of the male scale, this being a felted sac of the type found in *Chionaspis* but without traces of dorsal carinae, and not similar to that of the female in the sense in which this is true of the male scale of *Lepidosaphes.* As will be noted, the present interpretation of the pygidial marginal structures differs quite materially from that of Leonardi.

Genus ALLANTOMYTILUS Leonardi.

Plate 6, fig. 3.

Genotype.—*Mytilaspis maideni* Maskell.

Reference.—Fernald, Cat. Cocc. World, 1903, pp. 304, 311.

Only the type species has ever been placed in this subgenus which was first erected by Leonardi in 1897 wholly on the basis of the strongly transversely corrugated covering scale of the female, and which appears to have been abandoned completely by him subsequently, as no other reference to it on his part has been located, not even in his Monograph of the genus "*Mytilaspis.*"

The Maskell collection contains three slides of this species, one of "adult female, 1896," one of "male, 1896," and one of "♂ and ♀ puparia." There is also a small quantity of unmounted material under No. 520, while the National Collection of Coccidae contains a quantity of material from the type lot, received from Mr. W. W. Froggatt.

Adult female.—Scale as described by Maskell; body short mytilaspiform, broadest behind the middle, the cephalothoracic region somewhat chitinized, the abdomen membranous except the pygidium; antennae represented by a circle with three setae; anterior spiracles with two to seven pores, posterior without pores; thoracic and abdominal segments at and near margin ventrally with clusters of rather numerous tubular ducts, cephalothorax with occasional small setae;

posterior abdominal segments with stout gland spines and dorsal tubular ducts; pygidium short, very broad, posterior margin almost truncate; with three pairs of lobes, all small, all widely separated, the third pair a little smaller, not very strongly projecting, rounded conical, the first two pairs indistinctly notched on inner and outer

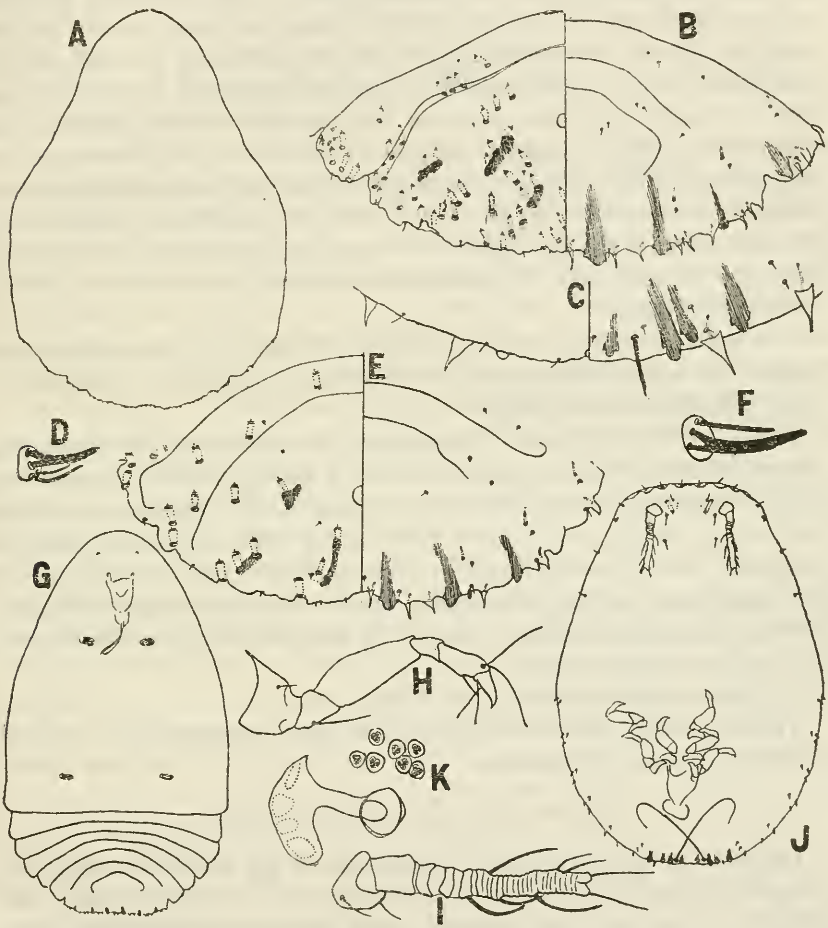

FIG. 35.—ALLANTOMYTILUS MAIDENI (MASKELL). A. INTERMEDIATE STAGE, CAST SKIN, OUTLINE, ×180; B. ADULT FEMALE, PYGIDIUM, ×220; C. LARVA, APEX OF ABDOMEN, ×640; D. INTERMEDIATE STAGE FEMALE, ANTENNA, ×640; E. INTERMEDIATE STAGE FEMALE, PYGIDIUM, ×335; F. ADULT FEMALE, ANTENNA, ×640; G. ADULT FEMALE, OUTLINE OF BODY, ×57.5; H. LARVA, LEG, ×640; I. LARVA, ANTENNA, ×640; J. LARVA, CAST SKIN, ×165; K. ADULT FEMALE, SPIRACLE, ×640.

sides; with a number of small tapering gland spines as follows: two median, two between first and second lobes, three between second and third lobes, two or three outside of third lobes, the largest of these at most only a little longer than the lobes; marginal spines present, small, inconspicuous, dorsally with one inside and one outside the first

lobe, and one outside the second and third lobes, ventrally with a similar spine corresponding to each of these except the median; without marginal incisions with thickened edges or chitinous paraphyses; anal opening nearly circular, placed close to the anterior apex of the pygidium; paragenitals wanting; marginal pores present, one above and anterior to the first and second lobes, sometimes with another between these two, two inside the third lobes and one just within the marginal notch ending the pygidium; dorsal pores present, rather numerous, more or less definitely grouped, but not in conspicuous rows of closely set pores, three or four anterior to and between median lobes, perhaps fourteen altogether anterior to and between first and second lobes, perhaps four or six between second and third lobes, about five or six next to notch terminating pygidium; without any distinct internal thickenings; no ventral micropores noted, this perhaps due to condition of specimens examined; with some small ventral surface setae.

Intermediate stage female.—Differing from the adult chiefly in the smaller size and in the reduced development and numbers of the structures described for the adult.

Larva.—Oval, antennae 6-segmented, the terminal annulate, legs normal, slender, with a pair of large long tubular double gland tubes near the anterior end of the body; margins of the abdominal segments with small single gland spines alternating with tiny setae; apex of abdomen with a median pair of tiny lobe-like protuberances, then the apical seta and a gland spine, then a relatively large lobe, then a rather large gland spine, followed by another lobe, and well beyond this another gland spine.

Cotype.—Cat. No. 24779, U.S.N.M.

The following generic diagnosis has been prepared from the description of the type species:

GENERIC DIAGNOSIS OF ALLANTOMYTILUS.

Diaspine forms most closely related to, if not identical with, *Coccomytilus* and *Lepidosaphes*; scales elongate, exuviae terminal, scale strongly corrugated transversely; adult female mytilaspiform, with minute antennae; margins of cephalothorax and abdominal segments with tubular ducts and small setae; abdominal segments also with some marginal gland spines; pygidium very short, apical margin nearly truncate; with small, widely separated lobes, gland spines, normal marginal setae, no incisions or chitinous paraphyses, anal opening nearly circular, near anterior edge of pygidium, marginal and dorsal pores present, axis longitudinal; intermediate stage similar but with structures less developed; young larva oval, antennae 6-segmented, terminal annulate, legs normal, slender, anterior apex

of body above with a pair of large tubular ducts, margin of abdomen with small gland spines and setae, apex of abdomen with large apical setae. definitely developed lobes and gland spines and marginal setae.

Genus ANOPLASPIS Leonardi.

Plate 6, fig. 4.

Genotype.—*Mytilaspis metrosideri* Maskell.

References.—Fernald, Cat. Cocc. World, 1903, p. 311.—Ferris, Can. Ent., vol. 52, 1920, pp. 63–4.

The confusion created by Leonardi in regard to the type species of this genus has been fully discussed by Ferris (1920), and is not commented on here further than to say that *M. metrosideri* stands as the type. Curiously enough, a still greater degree of confusion was found to exist when Maskell's specimens of this type species were examined, as it was found that Maskell had confused two distinct species, apparently cougeneric, and from the same host, and had sent specimens not the type species to other coccidologists as specimens of *metrosideri.* It has consequently been necessary to redescribe the second species in the Maskell collection. The writers are indebted to the note on the genus by Mr. Ferris for the information that *Mytilaspis metrosideri* Maskell and not *Aspidiotus bambusarum* Cockerell is the true type species.

The Maskell collection contains two slides bearing the name "Mytilaspis metrosideri," one of "female and puparium, July, 1890," and one of "adult female, 1891," and a small amount of unmounted material under No. 17. The slide mounts are really an undescribed species, and will be discussed later under the description of this new species. From the material still unmounted, it has been possible to obtain a mount of a female from the true type material, as determined by a comparison with Maskell's original description and figures, and it is this mount which is redescribed below. Material presented to the Bureau of Entomology collection by Maskell proves to be the undescribed species. What Leonardi had before him when he first established the genus it is impossible to state, but the species sent to Cockerell and, as stated, to the Bureau of Entomology by Maskell was incorrectly determined and favors the inference that Leonardi also had incorrectly determined specimens before him.

Adult female.—Scale white, elongate, pyriform, the anterior apex slender, the exuviae apical, yellowish brown; body elongate, broadest behind the middle, somewhat pyriform, but with the pygidium large, prominent and triangular, and the anterior body apex rounded; derm membranous, antennae placed in small pits in the head, tiny tubercles with a single large seta; eyespots represented by clear

circles, one to each side of the head near antennae; spiracles slender, anterior with 3–4 pores, posterior without pores; head region with a few small setae; margins of posterior thoracic and the abdominal segments with clusters of short tubular ducts and tiny setae, but no gland spines; abdominal segments with similar clusters of smaller pores in line behind the posterior spiracles; pygidium large, strongly triangular; median lobes present, large, contiguous, the inner edges fused, at least at tips, the two outer margins forming a well-defined

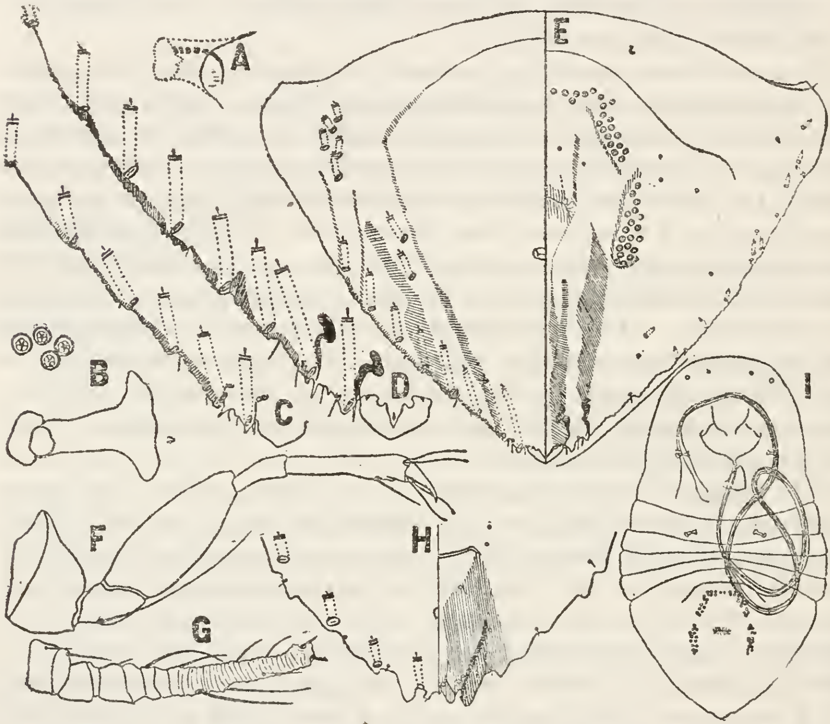

Fig. 36.—Anoplaspis metrosideri (Maskell). A. Adult female, antenna, ×640; B. adult female, spiracle, ×640; C. intermediate stage female, pygidial margin, ×335; D. adult female, pygidial margin, ×335; E. adult female, pygidium, ×165; F. larva, leg, ×640; G. larva, antenna, ×640; H. larva, apex of abdomen, ×335; I. adult female, outline of body, ×57.5.

obtuse triangle, second lobes represented by a small, slender, asymmetrically tapering lobe closely applied to the large protruding tubular duct opening lying just within it, third and any additional lobes represented by heavy, almost continuous serration and denticulation of the pygidial margin, running nearly to the base of the pygidium; gland spines small and inconspicuous, two only on each side, one just outside each median lobe, and one just inside the second long marginal tubular duct, each apparently connected with a long, slender internal structure that gradually expands anteriorly and is strongly clubbed and bent inwards at its inner end, these

probably representing very heavily chitinized ducts of the type usually attached to the gland spines; marginal setae, dorsally, with one tiny seta at the outer basal angle of each median lobe, one large and stout one above the reduced second lobe, one large and stout one just outside of the second marginal tubular duct, one large one just outside the fourth marginal tubular duct, ventrally all large and stout, one outside of second lobe, one just inside of third tubular marginal duct, one, small, half-way between fourth and fifth tubular ducts; without incisions with thickened edges or chitinous paraphyses as in some Aspidioti; anal opening medium, circular, a very little nearer to base than to apex of pygidium; paragenitals numerous, in five groups, linear, and often indistinctly segregated, median 5–6, anterio-laterals 16–22, posterio-laterals 16–19; marginal tubular ducts of two sizes, the normal ones large and very long, one outside of first gland spine, one outside of second gland spine, then three at intervals about equal to the space between the first two, then three more at wider intervals; with much smaller tubular ducts, possibly corresponding to those opening into the gland spines when these are present, beginning opposite the fifth large duct, with four between the fifth and ninth large duct; and 6–8 along the margin anterior to the ninth large duct; with dorsal ducts, these nearly as large and long as the marginal, few in number, two to three in first group, opposite posterior end of posterio-lateral paragenital group, five to six in the anterior group, opposite the anterior portion of the paragenital arch; pygidium without basal thickenings but with broad thickenings running in from the posterior margin dorsally, the median pair of these continuing to well beyond the anal ring, the two laterals on each side nearly as far.

Intermediate stage female.—Similar to the adult, apparently differing only in the smaller size, the somewhat reduced development of the different glands, etc., and in the absence of paragenitals.

Larva.—(Cast skin only.) Antennae 5-segmented, the terminal annulate; legs normal; apex of abdomen with a pair of tiny diverging median lobules, one pair of well developed lobes between which are two tubular ducts, two pairs of ventral setae, one large (apical) and wanting in specimens studied; with a dorsal and ventral seta, then a tubular duct, then a marginal lobe, then another dorsal seta, and a ventral seta, a tubular duct, etc., outside of the median lobe; with a few scattered ventral surface setae.

Cotype.—Cat. No. 24780, U.S.N.M.

The presentation of the generic diagnosis is deferred until the description of the following new species has been given, as both species are covered in the genus description.

ANOPLASPIS MASKELLI, new species.

Plate 6, fig. 5.

Adult female.—Scale white, flat or nearly so, broadly pyriform to sometimes almost circular, exuviae apical; body of female elongate turbinate; derm membranous; pygidium somewhat chitinized; antennae small tubercles placed in a pocket as in preceding species, each with a single large seta; spiracles slender, anterior with about 15 pores, posterior without pores; head with a few setae, thoracic

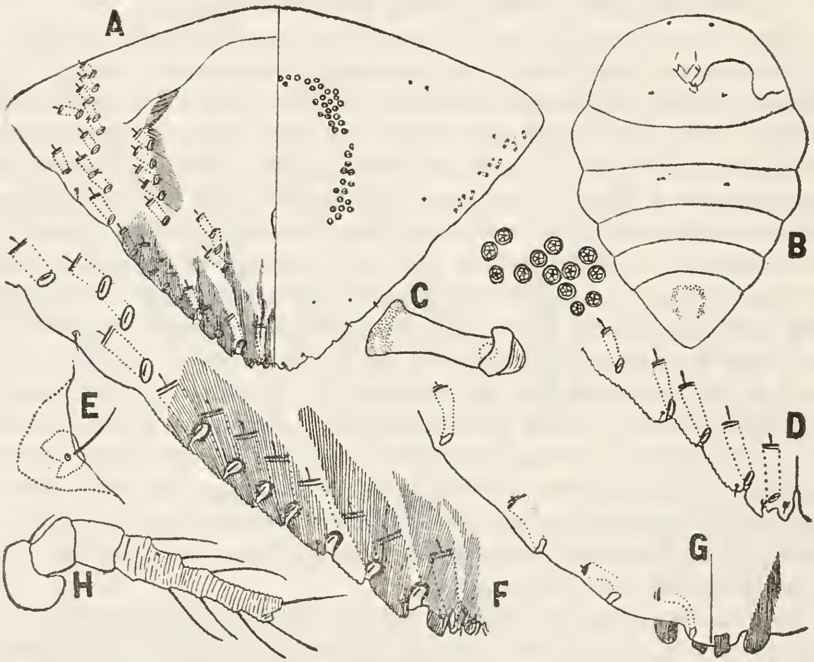

FIG. 37.—ANOPLASPIS MASKELLI, NEW SPECIES. A. ADULT FEMALE, PYGIDIUM, ×165; B. ADULT FEMALE, OUTLINE OF BODY, ×30; C. ADULT FEMALE, SPIRACLE, ×640; D. INTERMEDIATE STAGE FEMALE, PYGIDIAL MARGIN, ×335; E. ADULT FEMALE, ANTENNA, ×640; F. ADULT FEMALE, PYGIDIAL MARGIN, ×335; G. LARVA, APEX OF ABDOMEN, ×640; H. LARVA ANTENNA, ×640.

and abdominal segments with groups of medium sized short tubular ducts at margins, without gland spines; abdominal segments with groups of small, short tubular ducts in a row behind each posterior spiracle; pygidium strongly triangular, but with the extreme apex rounded; median lobes present, small, short-spatulate, placed close together, but separated by two small gland spines, second lobes larger and broader, the inner apical angle much more prominent, the outer margin parallel to the pygidium, third and any other lobes represented by almost continuous serrated and notched thickenings of the pygidial margin; with the two median gland spines already men-

tioned, with a small one outside of each median lobe, and another small one outside each second lobe; marginal setae, dorsally one above median lobe, one above inner corner of second lobe, one above inner end of beginning of chitinized margin, one just beyond fourth marginal tubular duct and one beyond ninth tubular duct, ventrally with one beneath the outer edge of the median lobe, one just outside the second lobe, one just within the third marginal duct, one beneath the fifth duct and one beyond the ninth duct; without incisions with thickened edges or paraphyses, but the edges of some of the marginal duct openings more or less thickened. and apparently with faint chitinized thickenings connected with at least the second pair of gland spines; anal opening elongate ovoid, placed about half way between base and apex of pygidium; paragenitals in five linear groups, the anterior three more or less confused, median 7–9, anterio-laterals 14–22, posterio-laterals 14–19; marginal pores large, fairly long, one opening into a pointed projection between first and second lobes, and seven or eight more, at approximately equal intervals, except the last one or two more widely separated, all these opening within the margin and the openings with thickened edges; dorsal pores large, in three rows, the inner with 2–4 pores, the intermediate with about five and the outer with about 7–9; without micropores, but with a few small tubular ducts ventrally near the margin; with a few small setae ventrally.

Intermediate stage female.—(Cast skin only.) So far as can be determined, differing from the adult only in the smaller size and reduced development of the different structures.

Larva.—(Cast skin only.) Antennae apparently 4-segmented, the terminal annulate; posterior apex of body with two small tubercles, a pair of marginal tubular ducts, a pair of lobes and at least three more ducts at intervals.

Holotype and Paratypes.—Cat. No. 24781, U.S.N.M.

This species has been described from seven specimens as follows: holotype from specimens in the Department of Agriculture Collection received from Maskell directly. paratypes from same collection, from the Cockerell collection now included in the National Collection, and from Maskell's slides, all labeled *M. metrosideri* Maskell. The holotype and some paratypes of this species are therefore in the National collection of Coccidae, and some paratypes are in the Maskell collection. The species was collected on *Metrosideros* in New Zealand, presumably by Maskell, and in 1890 or 1891.

The following generic diagnosis has been prepared to include both of the preceding species.

GENERIC DIAGNOSIS OF ANOPLASPIS.

Diaspine forms of somewhat uncertain affinities, possibly to be included in the *Lepidosaphes* group of genera;[17] scale of adult female nearly circular to pyriform, exuviae apical; adult female elongate turbinate to somewhat pyriform, membranous except portions of the pygidium; antennae minute tubercles with a single seta, each set in a small pit in head; spiracles slender, anterior with pores, posterior without; head with tiny setae but no pores; thorax and abdomen with tubular ducts and setae at margin, but no gland spines; pygidium large, prominent, strongly triangular, lobes present, the median fused or separate, the lateral margin beyond the lobes heavily chitinized and serrate or denticulate, with one or two pairs of small and very inconspicuous gland spines accompanying the lobes, marginal setae normal and occurring singly, without incisions or chitinous paraphyses, anal opening moderate, approximately half-way between base and apex of pygidium, paragenitals present, numerous, in five linear groups, marginal ducts large, numerous, not grouped, axis longitudinal, dorsal ducts large, in three definite rows, a single group to each row, without micropores, with a few ventral setae, without basal thickenings, with large, conspicuous, broad thickenings extending in from the posterior margin; intermediate stage female essentially similar to adult; larva with 4-5-segmented antennae, the terminal annulate, apex of body with a median projection, a pair of lobes and several pairs of marginal tubular ducts, the inner pair within the lobes.[18]

In spite of the differences noted, chiefly with relation to the rather conspicuous divergence in the character of the median lobes, and to the shape of the body in the two species discussed herewith, the writers believe them to be congeneric, since the resemblance in practically all of the remaining comparative characters is close.

It is not possible at present to give any more definite indication of the relationships of the genus than that suggested in the generic diagnosis.

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[17] The writers believe that the male scale of both these species was observed in the Maskell material, and that it was similar in shape and appearance to that of the female. The material was so limited, however, that the preceding can not be stated positively.

[18] The similarity in the apex of the abdomen of the larva in these two species is noteworthy, in contrast to the marked differences in the adults. While a careful effort was made to keep all stages of these two species separate, it is possible, since they were both enclosed in the same package, that the larva became scattered before new mounts were made, and that as a result the larva of the same species has been described twice. The material available for study does not permit an attempt to verify this possibility, and it is therefore necessary to let the larval descriptions stand as distinct, pending the examination of additional material. In this connection it may be noted that the difference of one segment in the number found in the antennae may also prove to be more apparent than actual when an abundance of good material is available for examination.

BIBLIOGRAPHY OF MASKELL PUBLICATIONS ON COCCIDAE.

The following list, arranged chronologically, is believed to be a complete record of the papers published by Maskell on the scale insects:

1879. On Some Coccidae in New Zealand. Trans. New Zealand Inst., vol. 11, for 1878, pp. 187–228, pls. 5–8.

1880. Further Notes on New Zealand Coccidae. Trans. New Zealand Inst., vol. 12, for 1879, pp. 291–301, pl. 7.

1882. Further Notes on Coccidae in New Zealand, with descriptions of new species. Trans. New Zealand Inst., vol. 14, for 1881, pp. 215–229, pls. 15–16.

1884. Further Notes on Coccidae in New Zealand. Trans. New Zealand Inst., vol. 16, for 1883, pp. 120–144, pls. 1–2.

1885. Chermes or Kermes. Trans. New Zealand Inst., vol. 17, for 1884, pp. 17–18.

——. Further Notes on Coccidae in New Zealand. Trans. New Zealand Inst., vol. 17, for 1884, pp. 20–31, pl. 8.

1887. On the Honeydew of Coccidae and the Fungus Accompanying these Insects. Trans. New Zealand Inst., vol. 19, for 1886, pp. 41–45, pl. 1.

——. Further Notes on New Zealand Coccidae. Trans. New Zealand Inst., vol. 19, for 1886, pp. 45–49, pl. 2.

——. An Account of the Insects Noxious to Agriculture and Plants in New Zealand, The Scale Insects (Coccidae). Wellington, 1887, 116 pp., 23 pls.

1889. On Some new South Australian Coccidae. Trans. Royal Soc. South Australia, vol. 11, for 1888, pp. 101–111, pls. 12–14.

——. On the Distinction between Lecanidinae, Hemicoccidinae and Coccidinae. Ent. Month. Mag., vol. 25, 1889, pp. 405–409.

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EXPLANATION OF PLATES.

The photographic illustrations of the habit characteristics of the various species shown in these plates have, with the single exception noted, been prepared by Mr. J. G. Pratt, photographer for the Bureau of Entomology. No attempt has been made to photograph the insects to a definite scale of enlargement, and the text of this paper or Maskell's publications should be consulted for information as to the actual size of each species. Due either to the poor condition or the lack of material of a number of Maskell's species, it has not been possible to obtain photographs of them, and in consequence the series is not complete.

Plate 1.

Fig. 1. *Monophlebulus fuscus* (Maskell), adult female.
2. *Coelostomidia zealandica* (Maskell), tests of intermediate stage females.
3. *Phenacoleachia zealandica* (Maskell), adult male and adult female.
4. *Frenchia casuarinae* Maskell, adult females, from above and in position within gall.
5. *Solenococcus fagi* (Maskell), tests of adult females. (J. G. Sanders, photo.)

Plate 2.

Fig. 1. *Ericoccus eucalypti* Maskell, sacs of adult females on twigs.
2. *Cylindrococcus casuarinae* Maskell, adult female galls.
3. *Sphaerococcopsis inflatipes* (Maskell), female tests on bark.
4. *Callococcus pulchellus* (Maskell), female tests on twig.
5. *Eremococcus pirogallis* (Maskell), female galls.

Plate 3.

Fig. 1. *Epicoccus acaciae* (Maskell), adult females on twigs.
2. *Pseudoripersia turgipes* (Maskell), adult female sacs on twigs.
3. *Chaetococcus bambusae* (Maskell), adult females.
4. *Ceronema banksiae* Maskell, adult female on leaf.
5. *Eriochiton hispidus* Maskell, female tests on leaf.

Plate 4.

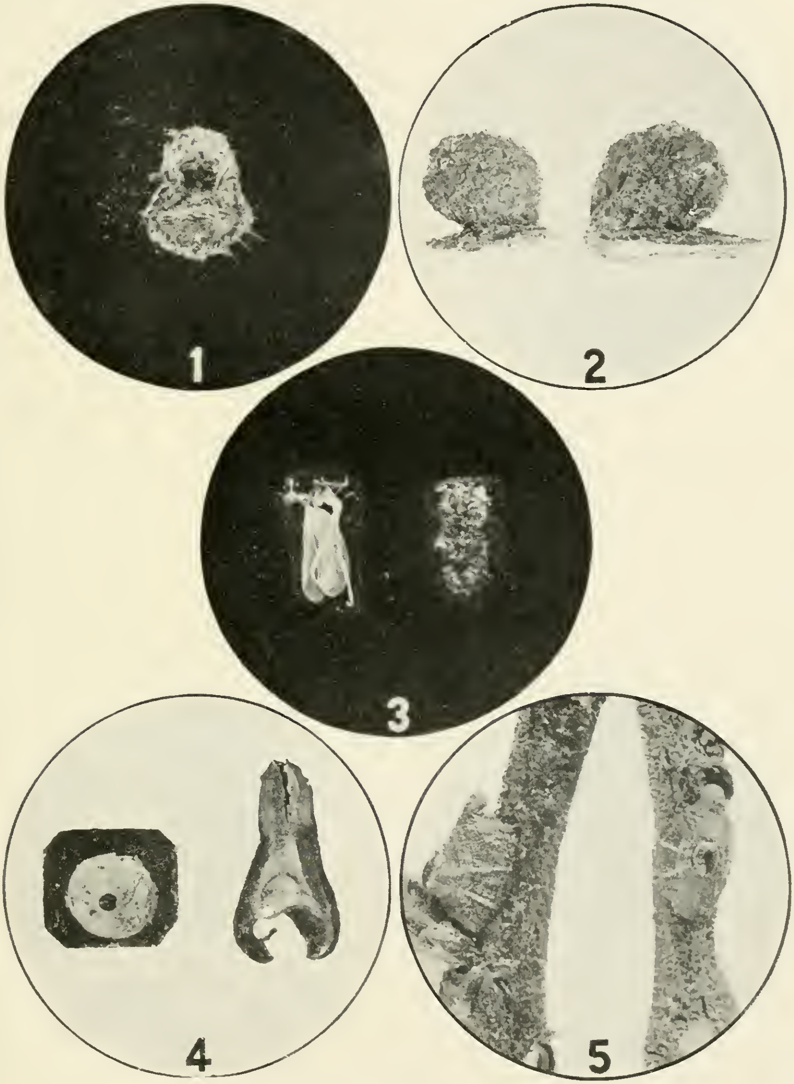
Fig. 1. *Mallococcus sinensis* (Maskell), female tests on twig.
2. *Lecanochiton metrosideri* Maskell, female tests on twig.
3. *Ctenochiton viridis* Maskell, adult females.
4. *Inglisia patella* Maskell, female tests.
5. *Paralecanium frenchii* (Maskell), adult females (not Maskell specimens).

Plate 5.

Fig. 1. *Cryptes baccatus* (Maskell), male puparia and females.
2. *Alecanopsis filicum* (Maskell), adult female.
3. *Poliaspis media* Maskell, female scale (probably not true *media*).
4. *Phaulaspis hakeae* (Maskell), female scales on bark.
5. *Phaulomytilus striatus* (Maskell), female scales on host.

PLATE 6.

FIG. 1. *Coccomytilus convexus* (Maskell), female scales on host.
2. *Trichomytilus formosus* (Maskell), female and male scales on leaf.
3. *Allantomytilus maideni* (Maskell), female scales on leaf.
4. *Anoplaspis metrosideri* (Maskell), female scales.
5. *Anoplaspis maskelli*, new species, female scales on leaf of host.

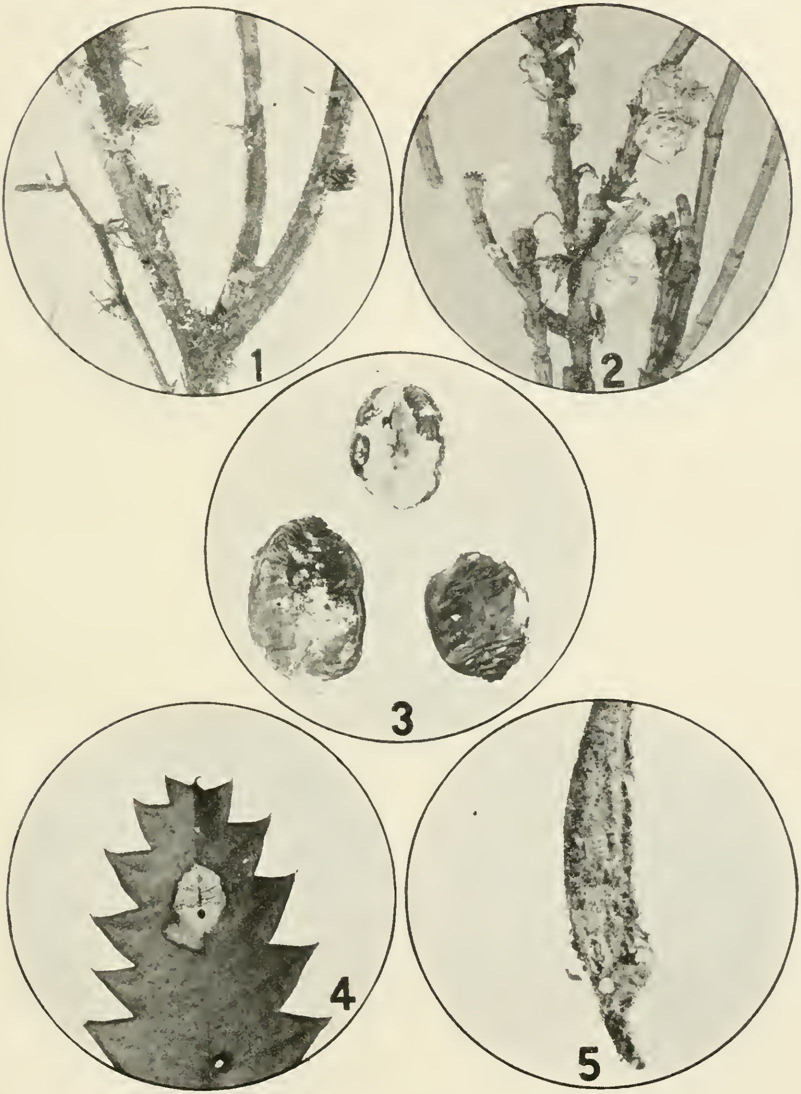


MASKELLS GENERA OF COCCIDAE

FOR EXPLANATION OF PLATE SEE PAGE 117.

MASKELLS GENERA OF COCCIDAE

FOR EXPLANATION OF PLATE SEE PAGE 117



MASKELLS GENERA OF COCCIDAE

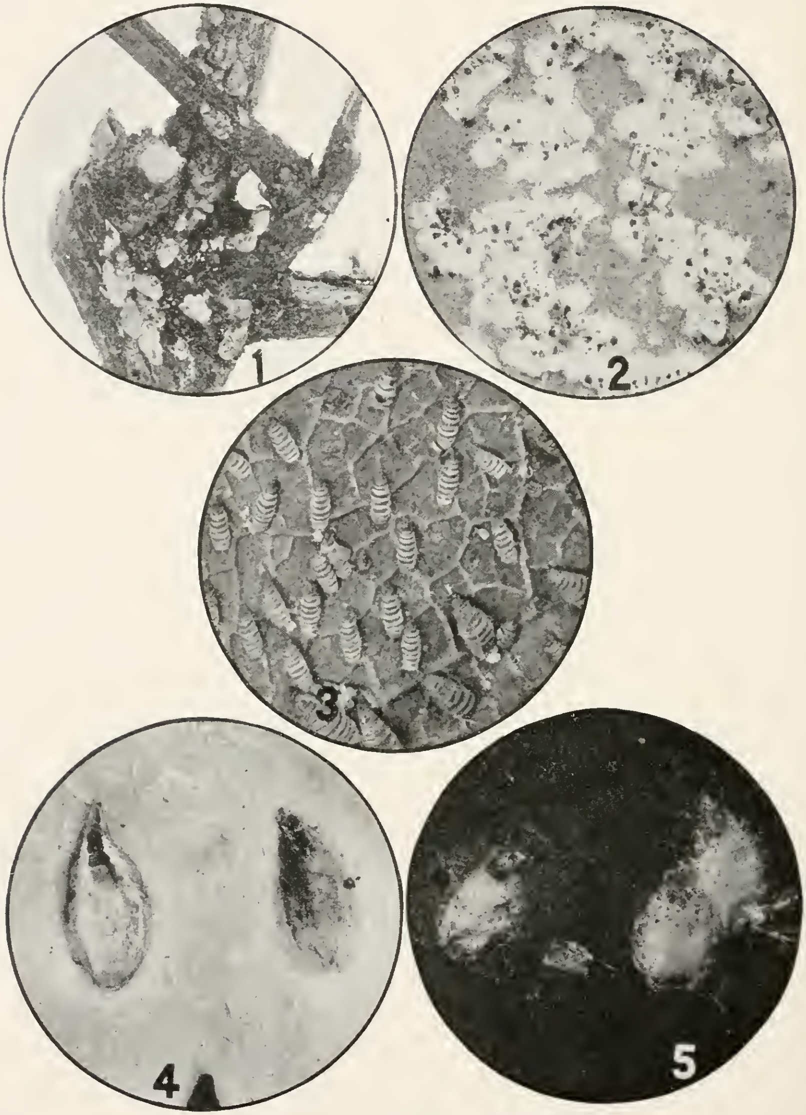
FOR EXPLANATION OF PLATE SEE PAGE 117.

MASKELLS GENERA OF COCCIDAE

FOR EXPLANATION OF PLATE SEE PAGE 117.

MASKELLS GENERA OF COCCIDAE

FOR EXPLANATION OF PLATE SEE PAGE 117.



Maskells Genera of Coccidae

For explanation of plate see page 118.

INDEX TO GENERA AND SPECIES.

[In the following index valid generic names are indicated in boldface type; valid specific names in roman, and synonyms in italics.]

ON A NEW SILURID FISH FROM THE YALU RIVER, SOUTH MANCHURIA.

By Arthur de Carle Sowerby.

While on a collecting tour on the Yalu River, South Manchuria, in the early summer of 1915, the writer secured a specimen of a peculiar catfish related to *Pseudobagrus tenuis* from the Yangtze Kiang, China, which was described by Guenther.[1]

The specimen was sent to the United States National Museum, where, recently, Mr. B. A. Bean, of that institution, and the writer have examined it, coming to the conclusion that it represents a hitherto undescribed form, which may be named—

PSEUDOBAGRUS EMARGINATUS, new species.

D. I, 7; A. 21; P. I, 7; V. 6; C. 20.

Body very elongate, cylindrical anteriorly, compressed posteriorly. Total length, excluding caudal, 16¼ inches. Greatest depth into length (excluding caudal) 8⅔. Smooth. Head depressed, wide, longer than wide and wider than deep. Length of head 6 times into length of body (excluding caudal). Snout bluntly pointed. Mouth inferior, rather small. Four pairs of barbels, two on maxilla, two on snout, of medium length, but apparently longer than in *P. tenuis*; posterior maxillary barbels half length of head, lower snout barbels somewhat longer. Eye small, 8⅔ into length of head.

Dorsal fin with stout anterior spine. The anterior spine of the pectoral also stout, and strongly serrate on the inner margin. Dorsal adipose fin very long. Caudal broad, deeply cleft, in which character it differs markedly from that of *P. tenuis*, which is described as entire. Other fins as in *P. tenuis*.

There is a peculiar short, stout, and pointed anal papilla present. The lateral line is pronounced.

Color.—General olive yellow in life, changing to dusky olive when the fish is in deep water.

Type.—Cat. No. 76716, U. S. N. M.: Orig. No. 222. Taken at the mouth of the Hun Kiang, in the Yalu River, on the South Manchurian border.

[1] Ann. Mag. Nat. Hist., ser. 4, vol. 13, 1873, p. 244.

No. 2408—Proceedings U. S. National Museum, Vol. 60, Art. 13.
3136—22—Proc.N.M.Vol.60——36

This species is nearest to Guenther's *P. tenuis* from the Yangtze Kiang, China, but differs in having the eye smaller, the barbels slightly longer, and the caudal deeply cleft. It is very much more elongate than Dybowski's *P. ussuriensis* from the Ussuri, Amur, and Sungari Rivers, which species it otherwise closely resembles, except in its emarginate caudal.

The writer is indebted to the authorities of the United States National Museum for permission to examine and describe this new fish.

THE JADE OF THE TUXTLA STATUETTE.

By Henry S. Washington,
Of the Geophysical Laboratory, Carnegie Institution of Washington.

Introduction.—One of the most interesting of the small objects that have come down to us from the ancient Maya civilization is the so-called Tuxtla [1] statuette, which has been described by W. H. Holmes.[2] This object was ploughed up in 1902 "in the district of San Andrés de Tuxtla on the Gulf coast of Mexico, about 100 miles southwest of Vera Cruz," and was later acquired by the United States National Museum (No. 222,579).

The statuette is of special importance because, according to Morley,[3] it is the oldest known dated object in American art. The date assigned by Morley to the statuette, from study of the central front row of glyphs, and assuming the contemporaneity of the inscription and the statuette, is 8. 6. 2. 17. 8 Caban 0 Kankin, in Mayan chronology, which corresponds to 96 B. C., according to Morley's recently published correlation of the Mayan and Christian chronologies.[4] It thus antedates the coming of Columbus by about sixteen hundred years.

The material of which the statuette is composed is obviously a "jade." It was examined years ago by Wirt Tassin, then an assistant curator in the United States National Museum, who reported it as nephrite, by which name both Holmes and Morley speak of the material. There appears to be no report extant of the results of Tassin's examination, nor record of any analysis by him. The present study, by optical and chemical methods, shows that the material is not nephrite but a variety of jadeite.[5]

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[1] Pronounced *Tushtla*. In Maya x represents sh.

[2] W. H. Holmes, Amer. Anthr., vol. 9, p. 691, 1907. See S. G. Morley, Carnegie Publication No. 219, p. 402, 1920.

[3] S. G. Morley, Bur. Amer. Ethnol., Bull. 57, p. 196, 1915.

[4] S. G. Morley, The Inscriptions at Copan, Carnegie Publication No. 219, pp. 465-555, 1920.

[5] As is well known, the term "jade" is used for two different minerals, both of which have much the same properties so far as their employment in glyptic art is concerned; namely, *nephrite*, a lime-magnesia amphibole, and *jadeite*, a soda-alumina pyroxine, both silicates. Typical jadeite is purely sodic, but it often contains other isomorphous constituents giving rise to varieties. We shall distinguish here betwee *soda jadeite* and the mixture *diopside jadeite*, the latter containing lime and magnesia in addition to soda.

Through the great kindness and courtesy of Dr. W. H. Holmes, to whom I would express my sincere thanks, I was privileged to examine the figure in the Geophysical Laboratory, and to remove enough material for chemical and optical study. I have also to thank Dr. S. G. Morley for his assistance and interest in the matter. I would also express my thanks to Drs. H. E. Merwin and L. H. Adams, of the Geophysical Laboratory, the former of whom undertook the optical examination, while the latter determined the density. I am under obligations to Dr. Charles W. Richmond, of the United States National Museum, for his identification of the species of bird.

Description.—It is not necessary here to describe the statuette at length, or even to discuss the glyphs and other archaeological features. Photographs of it are given in plates 1 and 2, the glyphs having been rendered more clearly visible by rubbing with chalk. The four excellent colored plates published by Holmes give a very faithful rendering of the form and color, and even a suggestion of the texture and luster of the statuette.

The rounded, conical image (flattened on the back) represents an oldish man, bald-headed, with the beak of a duck-like bird masking the lower part of the face, and mustache-like features connecting with the nostrils and folding down over the cheeks. If the carving represents a god, he must have been a beneficent one, for there is a merry twinkle in the eyes and a suspicion of a smile behind the beak that are facial characteristics widely different from the usually repellent features of gods as they are frequently depicted on the Mayan monuments.

The rendering of the beak indicates a faculty for observation that, perhaps, might scarcely be expected in an artist who is supposed to have worked at about the dawn of the Mayan historic period. The lamellirostral beak is anserine, but the feet are not webbed, and the original is thus probably the boatbill, (*Cochlearius cochlearius*) of the coast of southern Mexico and Central America, or *Cochlearius seledoni*, a Central American species. These are nocturnal, heron-like birds living along water coves on the coast. The beak is characteristic (more ducklike than that of the true herons). The grooves along each edge, the central ridge, and the oblique elongate, peculiarly shaped nostrils are all clearly and realistically shown. The details of the eyes and nose of the man and of the beak and the front edges of the wings of the bird are carved very sharply, in contrast to the rest of the figure, especially at the back. The statuette was apparently intended to be seen only from the front. This may indicate a later date for the glyphs on the back than for those on the front.

Below the head, the shape of the body is determined somewhat by the shape of the boulder out of which the statuette was carved. There are no arms but, as Holmes says, "The idea of the bird suggested by the beak is further carried out by wings covering the sides of the figure, the lower margins of which are engraved with alternating lines and rectangles to represent feathers." Legs and feet are indicated by incised lines below the wings.

The statuette has been made from a small boulder, of approximately the general shape of the figure, but with one end roughly sawed across, leaving a smoothish surface, which serves as the base.

Physical characters.—That the material is not of the usual extreme toughness, characteristic of most jade, is indicated by two rough gouges on the front and some spall scars on the front and back (at the bottom edge), the latter possibly the result of the figure having been set down too violently on a hard (stone) surface. It is also shown by the readiness with which the pieces that had been partly sawed out were pried off with a knife blade, as well as by the ease with which the fragments were reduced to fine powder for analysis. A similar brittleness has been found to be a character of other Middle American jades.

So far as I could see, there are no indications of the action of fire, and the fracture surfaces mentioned seem to have been the results of accidental percussion. At the lower left-hand corner of the back a thin slice was sawed out parallel to the bottom surface to furnish material for the examination by Tassin, and the space is now filled with plaster of Paris, in which is embedded a small piece of thin sheet iron. This is shown in figures 1, 2, and 3.

The height of the statuette is 15 cm., the extreme width across the base is 10 cm., and the depth across the base is 8.2 cm. The width across the shoulders is 6 cm., the length of the beak is 4 cm., and the distance between the eye pupils is 1.7 cm. The present weight is 2,259.48 grams, about 3 grams having been removed by me in obtaining material for the present study.

The surface is polished, especially on the front, but not highly so. The general color is a light, slightly yellowish and grayish green (Ridgway's[6] "pea green," 29 ' ' ' ' b), but it is somewhat mottled.

The hardness is 6.5, so that quartz tools could be used on the material. The density was taken twice by Doctor Adams, who has had much experience in determining the densities of rather large masses in his studies of glass and the compressibility of rocks. The first value found was 3.270 at 22°, and a second determination (made after the removal of the portion for analysis) gave the value 3.269 at 25.35°. Both values are probably slightly in error because of the

[6] Ridgway, Color Standards, Washington, 1912, pl. 47.

presence of the small amount of plaster of Paris and the bit of sheet iron, but the weight of these is so small relative to that of the stone that the value 3.270 may be accepted as that of the density of the Tuxtla jade, with a possible maximum error of ± 0.001 or 0.002. This density proves at once that we have to do, not with nephrite (the density of which is about 3), but with jadeite, though of a density slightly lower than that of the purely sodic mineral (3.3), and therefore presumably of abnormal composition.

Microtexture.—In thin section the jade is seen to be composed entirely of grains of clear, perfectly colorless jadeite, not a single particle of any other mineral having been detected in the thin section that was made. No zonal structure is seen in any of the grains. The texture is decidedly granular, but with some tendency to porphyroblastic texture. Some of the larger phenocrystic grains show an approach to automorphic outlines, and reach lengths of 1–3 mm. But the great majority of the grains are quite anhedral, and much smaller, from 0.1 to 0.5 mm. in diameter. Between these, here and there, are still smaller grains and granular fragments. All the grains are much cracked.[7] The rock has evidently undergone considerable crushing and possibly some slight recrystallization; but the grains are oriented quite at random, and there is no indication of schistosity or a fibrous texture. In short, the rock has the granular texture that is characteristic of jadeite, and not the fibrous texture of nephrite, a distinction that was pointed out many years ago by Clarke and Merrill.[8]

Optical characters.—Doctor Merwin reports as follows regarding the optical characters of the material: "Several measurements of the refractive index β indicated the crystals to be exceptionally homogeneous and uniform. Because of excessive crushing the optic axial angle was not sharply defined; it was estimated at 70° to 80°, and was found to be positive. Measurements of $\alpha \wedge c$ varied between 43° and 47°, with the optic plane in the plane of symmetry. The observed refractive indices were: $\alpha = 1.666$, $\beta - 1.674$, $\gamma = 1.688$, $\gamma - \alpha =$ .022. The optical properties of the mineral, as well as the chemical composition, agree with a pyroxene intermediate between diopside and jadeite."

Chemical composition.—Material for the chemical analysis, for the thin section, and for the optical determinations, was obtained by sawing two inclined cuts, about 1 inch long and one-third of an inch apart, in the bottom of the figure, giving what seemed to be average material. About 3 grams in all were removed, much of which was lost as dust, and two pieces were used for the section and for

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[7] The granularity and the cracked condition of the grains would account for the lack of toughness.

[8] F.W. Clarke and G.P. Merrill, Proc. U. S. Nat. Mus., vol. 11, pp. 115–139, 1888.

optical study. After pulverization the amount of material that was available for chemical analyses was 0.8367 gram. The results of the analysis are as follows, some analyses of other jadeites being given in the Table 1 for comparison:

Table 1.—Analyses of jadeites.

	1	2	3	4	5	6[9]	1a
SiO_2	55.50	57.14	56.63	58.33	58.18	58.80	.925
TiO_2	none.	n. d.	n. d.	n. d.	n. d.	n. d.	....
Al_2O_3	12.3	8.97	17.33	21.63	23.53	25.37	.121
Fe_2O_3	1.41	5.49	1.74	1.71	n. d.	0.33	.009
Cr_2O_3	none.	0.42	Trace.	n. d.	n. d.	n. d.	....
FeO	1.33	n. d.	0.22	0.73	1.67	n. d.	.018
MnO	0.05	n. d.	n. d.	n. d.	n. d.	n. d.	....
MgO	8.72	8.62	4.36	3.09	1.72	0.25	.218
CaO	12.76	14.57	13.35	4.92	2.35	0.58	.228
Na_2O	6.94	5.35	6.80	8.13	11.81	14.65	.112
K_2O	0.25	n. d.	n. d.	0.22	0.77	0.05	.003
H_2O+	0.10	n. d.	0.10	0.93	0.53	0.14	
H_2O-	0.20	n. d.					
	99.59	100.56	100.53	99.69	100.56	100.17	
Density	3.270	3.27	3.34	3.27	3.19	3.336	

1. Tuxtla Statuette. H. S. Washington, analyst.
2. China. A. Damour, analyst. Bull. Soc. Min. France, vol. 4, p. 158, 1881.
3. Val Susa, Piedmont. G. Aichino, analyst. S. Franchi, Boll. Com. Geol. Ital., 1900, No. 2.
4. Culebra, Costa Rica. F. W. Clarke, analyst. Clarke and Merrill, Proc. U. S. Nat. Mus., vol. 11, p. 125, 1888.
5. Zaachita, Mexico. Clarke, analyst. Clarke and Merrill, Proc. U. S. Nat. Mus., vol. 11, p. 122, 1888.
6. Tibet (?). H. W. Foote, analyst. S. L. Penfield in H. R. Bishop, Investigations and Studies in Jade, vol. 1, p. 126, 1906.

1a. Molecular numbers of 1.

It is evident that the analysis of the jadeite of the Tuxtla statuette differs notably from one of a purely sodic jadeite, such as No. 6.[9] The Tuxtla mineral contains much less silica, alumina, and soda, but more magnesia and lime. The absence of titanium, chromium (?), and manganese is to be noted. The density of the Tuxtla material is also markedly lower than that of sodic jadeite.

From the chemical and optical characters, from the density, as well as from the "exceptional homogeneity" of the Tuxtla jade, it is evident that we have to do with a complex pyroxene, composed of sodic jadeite in isomorphous mixture with other members of the pyroxene group. From the amounts of lime and magnesia present it is evident that diopside presumably makes up the greater part of the molecules that accompany the sodic jadeite.

[9] This analysis is of the specimen from which Penfield isolated two small crystals, on which he measured the crystallographic angles, and of which Merwin has determined the optical characters, some of which are given on a later page.

The percentage composition, in terms of mineral molecules, is given below. This assumes that all the soda (and potash) go into a jadeite molecule, that there may be present a so-called "babingtonite" ($FeO.(Fe,Al)_2O_3.4SiO_2$) molecule, that the CaO, MgO, and FeO (above that needed for babingtonite) form diopside, and that the extra Fe_2O_3 is present in the pyroxene in solid solution, instead of as the Tschermak molecule, the last assumption being in accordance with the results of as yet unpublished studies by Merwin and me on acmite-aegirite and other pyroxene minerals. The result is calculated to 100 per cent.

Molecular composition of Tuxtla jade.

Molecule.	Per cent.	
Jadeite ($Na_2O.Al_2O_3.4SiO_2$)	46.49	Jadeite, 49.34.
Babingtonite ($FeO.Fe_2O_3.4SiO_2$)	2.85	
Wollastonite ($CaO.SiO_2$)	26.64	Diopside, 50.66.
Enstatite ($MgO.SiO_2$)	21.95	
Ferrosilite ($FeO.SiO_2$)	1.59	
Ferric oxide (Fe_2O_3)	.48	
	100.00	

The Tuxtla jade is therefore composed of 49.34 per cent of sodic jadeite (with a slight admixture of potasic jadeite and babingtonite molecules), and 50.66 per cent of an almost purely magnesian diopside, containing only a little ferrous metasilicate.

The Tuxtla mineral is, therefore, strictly, a *diopside-jadeite*, with the two molecules present in almost exactly equal amount. For the benefit of archaeologists, who are not concerned with the niceties of mineralogical nomenclature, it may be said that they would be sufficiently correct to call the material jadeite, as it is a variety of this mineral, and by this name it is thus clearly distinguished from the other jade mineral, nephrite—a very important archaeological, as well as mineralogical, distinction.

In his interpretation of the analyses of jadeite in the Bishop collection, Clarke assumed the presence of a molecule (Ca, Mg, Fe) O. $Al_2O_3.4SiO_2$, which he called pseudojadeite ; while Penfield, although assuming that very small amounts of CaO, MgO, or FeO could replace Na_2O in jadeite, calculated the greater part of these RO oxides as forming diopside in the analyses of the Bishop jadeites which he discusses. Merwin and I, as has been said, seem forced to assume the presence of small amounts of the babingtonite molecule, $FeO.(Al,Fe)_2O_3.4SiO_2$, which is analogous to Clarke's pseudojadeite, in some acmites and aegirites. But study of the molecular ratios furnished by analyses of jadeite makes it clear that such a molecule

as Clarke's or ours, may be assumed to be present to account for only a very small percentage of RO; because for jadeites in which the percentages of CaO, MgO, or FeO are high (as in that of the Tuxtla statuette), the formation of such molecules demands more silica to satisfy them than is found to be present. This is because in these molecules the molecular amount of SiO_2 is four times that of RO, while in diopside they are equal. A diopsidic molecule must, of course, be assumed if the molecular amount of R_2O_3 is less than that of R_2O+RO. It may be mentioned here, in anticipation of future publication, that a study of jades from a *cenote* at Chichen Itza, in Yucatan, now being prosecuted, shows that the presence of the diopside molecule is a marked characteristic of the jades of Middle America (Mexico and Central America), as contrasted with those of Burma, and that the jade of the Tuxtla statuette is an end member of a series of albite-jadeite rocks.

That diopside-jadeites chemically similar to that described here are not uncommon is evident from a survey of the published jadeite analyses, only a few of which are given in Table 1. Many jadeite analyses that show high lime and magnesia, such as those by Damour, are of rather early date and hence may not be altogether satisfactory, but it can not be supposed that analytical errors have been committed of such magnitude as to cause serious incorrectness in the large amounts of lime and magnesia shown by them. It is also noticeable that among analyses of jadeite, (especially from Middle America), there is a definite serial progression from pure soda jadeite to diopside-jadeite, shown by gradually increasing amounts of lime and magnesia and diminution in silica and soda, as well as by concomitant changes in density. A serial progression beyond, from diopside-jadeite to diopside, is scarcely evident.

Examination of the analyses of jadeites published in Doelter's Mineralchemie[10] (which include those in Bishop's Jade Book), indicates that there is a very decided difference between many of the jadeites of southeast Asia and those of Mexico and Central America. Most of the former are composed almost wholly of the purely sodic jadeite molecule, while many of the latter contain very considerable amounts of lime and magnesia, indicating the presence of the diopside molecule. It would appear that comparatively few of the American jadeites are almost purely sodic. To illustrate, the following table shows the averages of 15 analyses of jadeite from Burma (including Tibet) (1) and of 11 from Mexico and Central America (2) (taken from Doelter), the figures for only SiO_2, CaO, MgO, and Na_2O being given. The analysis of the Tuxtla statuette is included in the average of No. 2.

[10] C. Doelter, Handbuch der Mineralchemie, vol. 2, pp. 652—658, 1914.

Comparison of Jadeites from Burma and America.

	1	2
SiO_2	58.83	58.23
MgO	0.78	2.65
CaO	1.08	4.02
Na_2O	14.40	10.06

The difference is obvious. Of the American jadeites only 4, or about 33 per cent, show compositions that are closely similar to those of Burma. This is a subject which it is hoped to study soon in connection with some large collections of jades from Middle America.

Consideration of the densities of jadeites leads also to the suggestion of the possibility of the existence of a definite, equimolecular mixture of jadeite and diopside, possibly much as dolomite is related to calcite and magnesite. In a discussion of the densities of the jadeites of the Bishop collection, Hallock[11] shows that the average of 107 jadeites (including a few chloromelanites) is 3.3202. He then gives the following table of grouped averages, from which the chloromelanites are omitted:

43 jadeites average	3.3351
27 jadeites average	3.3252
8 jadeites average	3.3182
4 jadeites average	3.3041
19 jadeites average	3.2517

The average densities are clustered at either end. Using the figures given, if weights are assigned to the two heaviest and most numerous average densities according to the number of determinations, combining them we arrive at the result:

70 jadeites of average density	3.331
19 jadeites of average density	3.252

Between these there occur only 12 jadeites, with a wide interval between them and those of lowest density. These figures, so far as they go, would seem to indicate that archæological "jadeite" is mostly the pure soda jadeite, and that a fairly definite diopside-jadeite also occurs quite abundantly, but that there are comparatively few intermediate members of the series.

Because of the intermediate position of the Tuxtla diopside-jadeite it will be of interest to state succinctly the correlation of some of the properties of it and of the end members of the series. The data for soda jadeite were determined by Merwin on the two small crystals isolated by Penfield from the material the analysis of which is given

[11] W. Hallock. In H. R. Bishop's Jade Book, vol. 1, p. 116, 1906.

in Table 1, the crystals from the Brush collection[12] having been kindly loaned by Dr. W. E. Ford. Those for diopside were determined by Wright and Larsen[13] on the artificial mineral.

	α	β	γ	2V	a : c	d
Soda jadeite (Tibet)...........	1.655	1.659	1.667	Ca 70°	34½°	3.336
Diopside-jadeite (Tuxtla)......	1.666	1.674	1.688	Ca 75°	45°	3.270
Diopside (artificial)..........	1.664	1.671	1.694	59°	38½°	3.275

The refractive indices of the Tuxtla diopside-jadeite approach closer to those of diopside than to those of soda jadeite; this may be attributed to the presence of a small amount of babingtonite molecules, which would tend to raise the values for these constants. It is difficult to account for the anomalous extinction angle.

Provenance.—The question of the provenance of the jadeite (and chloromelanite) that was used by the ancient inhabitants of Mexico and Central America is one of great interest, and one that is as yet unanswered. It was suggested years ago by Pirsson[14] that jadeite may be formed through the metamorphism of highly sodic igneous rocks, such as nephelite syenite or phonolite. Bearing this possibility in mind, and taking into consideration the distribution through North America of igneous rocks of different general chemical compositions, I have for long had a suspicion that the original localities of the Mexican and Central American jadeites are along the Pacific coast, rather than in the interior or near the Gulf. The establishment of the occurrence among Mexican and Central American artifacts of two distinct kinds of jadeite—a soda jadeite and a diopside jadeite—might aid in throwing some light on the interesting problem of the provenance of the material, which has not yet been found *in situ*.

Some archaeological considerations.—Although not a student of American archaeology, I venture to add a few remarks on certain stylistic and archaeological features of the Tuxtla statuette; these may be of interest, though they are foreign to the subject of this paper. They are offered only because they are based on some general archaeological principles, applicable to Mayan as well as to

[12] In view of the difficult accessibility of the Bishop Jade Book it may be of interest to state the principal crystallographic results of Penfield, which do not seem to have become a part of the general literature of mineralogy. He found that jadeite is monoclinic, with a : b : c=1.103 : 1 : 0.613; angle β = 72° 44½′. The planes present were: $a(100)$, $m(110)$, $n(130)$, and $s(\bar{1}11)$; with the fundamental angles, $a \wedge m$=46° 29′, $m \wedge c$=58° 23′, and $s \wedge s$=61° 12′, also $a \wedge n$=72° 25′. The extinction angle on b (010) was 34°, and 2V=about 70°.

[13] Wright and Larsen, Amer. Journ. Sci., vol. 37, p. 33, 1909.

[14] L. V. Pirsson, Amer. Journ. Sci., ser. 4, vol. 1, p. 401, 1896; and in Bishop's Jade Book, vol. 1, p. 162, 1906.

Greek art, and because the ideas do not seem, as yet, to have been applied to the object of our present study.

1. The realistic treatment of the details of the bird's beak and the rendering of the wing plumage would appear to be an example of what is observed in the history of art among many diverse peoples: that is, primitive man and the earliest artists were close observers of animal life, and they were often able to depict animal forms very successfully, generally more so than they could the human. This is well known and is exemplified in Egyptian, Chaldean, Babylonian, Assyrian, Cretan, Greek, and even in Paleolithic art. It would appear that the early artist of the Tuxtla figure was no exception to the rule.

2. When we consider that this statuette is the earliest known dated cultural work of a semicivilized people, and that it belongs to probably near the beginning of their historic period, the marked realism and lively expression shown in the man's face are very striking—all the more so when the extreme conventionalism of the later Mayan sculpture is considered. One is inevitably reminded of the realism and expression shown in the sculpture of the early dynasties of the Ancient Empire of Egypt, of which Budge,[15] speaking of the tomb reliefs of the Fourth Dynasty at Gizeh, says: "Their fidelity to nature is surprising, and the skill with which they are executed, and their delicacy of detail, mark them for all time as masterpieces of art and sculpture, which the Egyptians under the later dynasties rarely equaled and never surpassed." Examples in the round that are well known to all are the Sheikh-el-Beled of the Bulaq Museum and the Seated Scribe of the Louvre. In Egypt this early and very successful realism disappeared in later times, and was replaced by a conventional treatment of the human figure and face that was imposed on the artist by the powerful priesthood, except during a brief period of freedom under Ahmenhetep IV. While one can not attribute to the Tuxtla statuette the high artistic qualities of the sculpture of the Fourth Egyptian Dynasty, yet in view of its artistic merits and freedom from formalistic restraint one is tempted to see a development in Mayan sculpture parallel to that in Egypt, both having been brought about by analogous influences.

3. The face of the Tuxtla figure, in its realistic rendering, differs much from most of the faces of Mayan art, which are not only conventionalized, but appear grotesque or caricaturelike to us. But differences that seem to be much more fundamental and due to a quite different cause are manifest; for example, in the breadth of the face, the elongated eyes, the straight and platyrrhine nose, and the peculiar, smilingly human expression of our figure, which are in

[15] E. A. W. Budge, Short History of the Egyptian People, p. 43, 1914.

marked contrast with the narrower and ovel face, the generally more rounded eye, the prevailing curved or aquiline nose, and the grim expression of most of the faces of later Mayan art. Some of these peculiarities of the Tuxtla statuette may, it is true, have been determined by the shape of the boulder from which the figure was carved. Most of the Mayan representations of the human face are in profile, except in the large stelae, and this may possibly account for some of the differences. But the differences between the Tuxtla and the usual Mayan sculptural representation of the face are so marked that it would seem to be possible that the Tuxtla statuette represents a racial type distinct from that of the Maya.[16]

4. It appears to be generally assumed that the Tuxtla statuette represents a god; but it is suggested here that it represents rather a priest dressed in ceremonial costume, who wears a bird mask and a cloak that simulates the body and wings of the bird.

Masks were commonly worn among Amerindian tribes during various ceremonies, with the object of representing some animal of totemic or other significance. The idea that the bird's beak is part of a mask is suggested by the fact that it is placed below the man's nose, leaving the whole of this and the upper part of the face visible, as well as the ears and ear plugs at the two sides. Some Amerindian masks covered only part of the face, as among the Hopis,[17] and Hodge gives an illustration[18] of a figure in repoussé copper from Etowah Mound, Georgia, who wears a mask that represents a bird's beak, with a strap covering the chin, the man's eyes, nose, and mouth being all very evident. There are examples in Mayan art of masks only partially covering the face, according to an oral communication from Doctors Morley and Spinden.

The legs and feet below the wings seem to me to be those of a man, rather than those of a bird, as the feet are quite thick and are curved at the heel and at the base of the toes; the toes, also, are parallel and are not divergent as are those of a bird. It is true that the feet are sketched in simply, with incised lines, but it is difficult to believe that the artist who could delineate the beak so well that the genus and even the species are recognizable should at the same time represent the flat, wide foot of the *Cochlearius*, with its highly divergent toes, in such an unnatural and uncouth way as we see here.

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[16] Doctor Morley was kind enough to read over this manuscript and has given me permission to say that, in his opinion, the stylistic and somatological differences are so marked that, were it not for the undoubtedly Mayan glyphs, the statuette would be incapable of interpretation as belonging to Mayan culture. This independent convergence of opinion lends some weight to the hypothesis that the Tuxtla Statuette is not of Mayan origin.

[17] F. W. Hodge, Handbook of American Indians, vol. 1, p. 815, 1912.

[18] Hodge, Idem., pp. 346 and 848.

That such a bird cloak as is here suggested was worn by the Amerindians is indicated by the same copper figure cited above from Hodge. Besides the bird mask the man wears an obvious cloak,[19] that is evidently part of his ceremonial costume. This cloak represents very clearly the bird's wings, the coverts and what appear to be the thumb wings being shown, while the long primaries make up the greater part of the cloak, and their tips form a fringe-like bottom, much as is indicated in the Tuxtla figure.

An additional resemblance between the two figures is that the legs of the copper figure are hanging and do not reach the ground, as is also the case with our figure; while the man appears to rest or be seated on a sort of pedestal, much as Apollo is represented on the omphalos in Greek art. The question arises whether the lower part of the Tuxtla statuette, on which the legs and feet are depicted crudely, may not represent a similar pedestal or seat of the "omphalos" form. Attention may also be called to the very similar representation of the ear and ear plug in the two cases.

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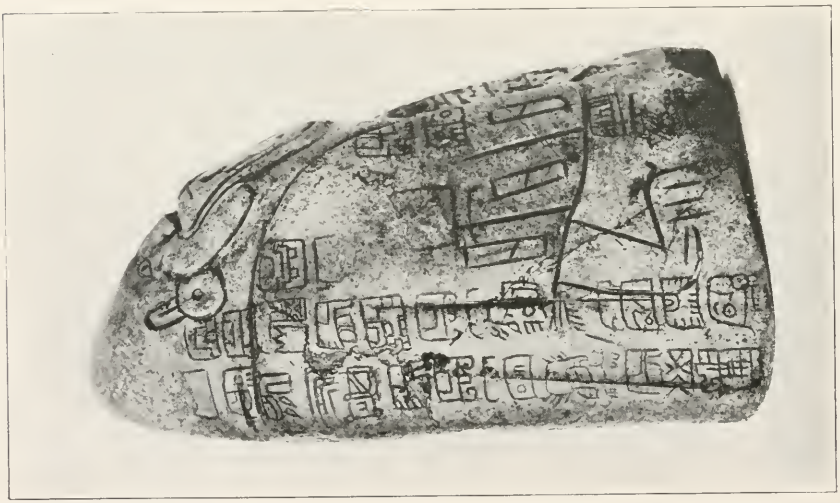
[19] This is seen better in the line-drawn restoration on p. 346, but it is easily visible in the photographic reproduction on p. 848.

TUXTLA STATUETTE. (FRONT AND BACK VIEWS.)

FOR EXPLANATION OF PLATE SEE PAGE 2.



TUXTLA STATUETTE. (RIGHT AND LEFT SIDE VIEWS.)

FOR EXPLANATION OF PLATE SEE PAGE 2.

SUGGESTIONS FOR COLLECTING AND PREPARING DIATOMS.

By Albert Mann,
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The study of the diatoms has taken on a much greater importance than formerly, because of the now generally recognized fact that the rôle they play in aquatic life, especially in the food supply of fishes, is a very great one. In their fossil state also new uses for diatom earth have been discovered and the amount of this material now supplied to the various industries is enormous. I have been asked to give some simple suggestions on the best methods for collecting these organisms and preparing them for microscopic study.

The living forms, inhabiting all waters, fresh and marine, will be first taken up. The presence of diatoms in any considerable quantity can be detected in quiet waters by the rich brown or yellowish-brown color of the film composed of diatoms, which coats the bottom of such places or clothes the submerged stones, sticks, and other bodies. By carefully removing this pellicle, for which a bent piece of tin or a clamshell are good instruments, the collector secures a rich gathering, very slightly mixed with dirt, sand, or other matter.

But there are few such places met with, especially in the collecting of marine diatoms. Two very distinct methods of securing material must be used, because we have to do with two unusually different habits of life of the diatoms. Some of these are plankton, that is to say, they live suspended in the water. The presence of the plankton forms is generally unsuspected, because they are not readily visible in the water, although generally present, and that, too, at times in immense quantities. The plankton diatoms are secured by means of a plankton net composed of silk bolting cloth with a mesh of about No. 18. This net is attached to a wire ring having a diameter of about 15 to 18 inches and is conical in shape, but should be as far as possible without folds, having a length of 2½ to 3 feet, and with the lower end or tip slightly rounded. This absence of folds can be secured by cutting the bolting cloth and carefully sewing up the seams with a double line of stitches so as to avoid any flaps. Attached to a stout cord by three lines tied to the wire rim at equidistant points, the

net is drawn through the water slowly, preferably back of a rowboat, until the desired quantity of plankton diatoms has been secured. This is washed into a jar, partly filled with water, by reversing the net. A small quantity of commercial formalin is then added to the jar to kill all the organisms and allow them to settle. The time required for settling depends upon the height of the water in the jar, but should be given an hour in a jar containing 10 to 12 inches of water, as the diatoms, which are characteristically delicate in plankton forms, settle slowly. When settling is complete the excess of water is very carefully poured away and the diatom sediment is bottled.

The method used for cleaning and preparing the more robust diatoms collected from the bottom of lakes, rivers, or the ocean, is not well adapted to these delicate plankton species and special methods are therefore necessary to prepare them for microscopic study. In general the material in the bottom of the bottle can be microscopically examined under a cover glass without further preparation; but as the markings upon many of the species are difficult to see in water, it is preferable to use a mounting medium of high refractive index. Several methods can be suggested. By transferring some of the material from the collecting bottle to a small homeopathic vial and gradually replacing it by alcohol, one can then mount the material in so-called gum thus, also known as frankincense. This is obtainable at most druggists. It is dissolved in pure alcohol to the consistency of thick syrup. After the diatoms have been transferred to a glass slide, and a drop of gum thus placed upon them and covered with a cover glass, the mount is ready for examination and has the advantage of being practically permanent, at least for several years. This mounting medium will bring out the markings of most of the plankton forms. There is, however, a better medium which, because of its very much higher refractive index, shows the more delicate structure which is hard to see in gum thus. This medium, a solution of barium mercuric iodide, is made as follows:

To a saturated aqueous solution to barium iodide is added red mercuric iodide until a slight excess of the latter remains undissolved. A drop or two of the saturated solution of barium iodide is then added, in order to effect the solution of this excess of the mercuric iodide. The perfectly clear yellow solution is now ready for use and can be kept indefinitely in a well-stoppered bottle. A minute quantity of the diatom sediment is placed by a pipette on the slide. This is taken from the collecting bottle where the diatoms are in weak formalin. The excess of water is drawn away from the material on the slide by means of a triangular piece of thin blotting paper or filter paper. A drop or two of the barium mercuric iodide is then added, the diatoms gently stirred in with the needle, and

covered with a cover glass. If it is desired to preserve this mount, any excess of the liquid is first removed from under the cover glass by means of another triangular piece of blotting paper; the mount is then sealed with a ring of hot paraffin, followed by one or two rings of some good cement.

It is also well to clean up a small portion of each sample of plankton material by the acid methods to be described under the next heading; as there are always a number of forms in most plankton gatherings sufficiently robust to stand this, and these forms are much better studied after such treatment than in the uncleaned condition of the mounts prepared by the foregoing methods. This is due to the removal of all organic matter from these denser diatoms and consequently the better view that is obtained of their sculpture. By using these two methods with plankton material, the student secures all the advantages of each, and has no difficulty in identifying all the species present.

We now turn to the collection and preparing of diatoms inhabiting the bottom of rivers, lakes, bays, etc. Aside from the places where diatoms can be collected in shallow waters, where they are seen by means of their color, as has been previously pointed out, the collector needs some form of dredge to obtain samples in the deeper water. The best dredge known to the writer is fortunately a very simple one, and one involving a very small outlay of money. This is made of about 15 inches of cast-iron drain pipe with a diameter of about 4½ inches. One end of this is closed, either by a shallow wooden plug or by brazing a circular piece of metal to the end. At the other end a stout wire bail is attached by means of two holes drilled through the pipe about an inch apart and as close to the edge as possible. The side of the rim opposite to this bail is sharpened on the inner side with a round file, so as to make a cutting lip.

The advantages of this dredge are several—its cheapness and the ability to have one made even at remote places; its indestructibility when used on stony bottoms; and the fact that it always secures a satisfactory amount of material, about a liter of the surface of sand or mud. It should be drawn very slowly over the bottom, either back of a rowboat, or from the beach by casting the dredge out and drawing it slowly ashore. It should be remembered that approximately five times the depth of the water should represent the length of line when dredging, otherwise the dredge may be tilted at the front end and fail to scrape up the bottom. When the dredge is near the boat and is to be lifted it should be done gently, otherwise its contents will be spilled. It should also be raised gently to the boat, so that the rush of water does not sweep out the material. If the bottom is muddy, the material must be put in a jar or bottle, and the mud separated in the laboratory. If the bottom is sandy, the

dredge should be dumped into a pail, about a pint of water added, and the whole violently stirred with a stick. After the stirring and as soon as the sand is thought to have settled, perhaps 30 seconds, the muddy water is poured into a battery jar, another pint of water is added and the process repeated. This washes the diatoms out of the heavy sand and concentrates the material. Formalin is now added to the jar, as previously directed, and after the material has thoroughly settled the water is carefully poured away and the sediment is bottled.

These two kinds of bottom samples are to be treated differently at the laboratory. The muddy material is separated as far as possible by decantation from its clay and other very fine material in the gathering. Muddy gatherings are also liable to contain particles of decayed sticks, leaves, etc., which would be difficult to destroy by acids and should first be removed by means of a piece of wire gauze, having a mesh of perhaps about one-half mm. By pouring the muddy gathering, well diluted with water, through this gauze, these larger particles will be removed and the process of cleaning now to be described will be rendered much easier. A small amount of the mud is placed in a battery jar, about 50 cc. to a jar holding a liter, and water added. It is best to add the water from the faucet with a powerful stream, so as to mix up the contents thoroughly, or the whole may be stirred with a rod or stick. When such a jar has stood for 45 minutes, the muddy water is poured away, fresh water is added, and the process is repeated until the water after 45 minutes is almost clear. From this point the samples from sandy and from muddy bottoms are treated the same way. The water is poured off and the material transferred to a beaker and about ten times its volume of commercial hydrochloric acid is added. This is to partially bring into solution the organic matter, but especially to remove all lime, such as shells, corals, etc. The material is boiled in the acid for about 20 minutes. The acid is then poured away, after the contents have thoroughly settled, fresh acid is added and again brought to a boil. Commercial nitric acid is now added to the boiling beaker, drop by drop, care being taken that the contents do not foam up over the beaker. This adding of the nitric acid to the boiling solution brings about the rapid oxidation of the organic matter in the sample and leaves as a residue only the diatoms, such sand as is present, sponge spicules, and other bodies composed of silica. The adding of nitric acid should be continued until the red fumes of nitrous acid produced by the oxidation process are no longer given off. The beaker is now filled with water and the sediment washed free of acids by repeated additions of water and decantation after settling. The material is now examined under the microscope, and in most cases it will be found to be clean, the diatoms present being bril-

liantly clear. But where the organic matter is very high, as it is in very muddy material, the washed residue must be passed through the sulphuric acid process. If this is needed, the water is very carefully poured away so as to remove as much of it as possible. The sediment is transferred to a small distilling flask, or if this is not available, to a porcelain evaporating dish. Sulphuric acid is carefully added to the wet material and the residue in the beaker is washed over into the distilling flask with sulphuric acid. The heat generated by the union of sulphuric acid and the material is high and care must be taken to avoid explosion. The mass is now boiled over a sand bath. It generally becomes perfectly black or a dark brown. The boiling should continue an hour or two, as the sulphuric acid evaporates very slowly in the evaporating dish and not at all in the distilling flask. There is now cautiously added to the boiling mass minute particles of sodium nitrate. This is accompanied by violent sputtering, oxygen is liberated, the organic matter is entirely oxidized and destroyed, and the mass becomes perfectly white or pale straw color. After it has become cold it is poured into a large beaker with a capacity of at least one liter, half filled with water, and water then added to fill the beaker. Battery jars will not do for this step, because the heat generated by the union of the sulphuric acid with the water is liable to crack the jar. The material is now freed from acid by settling and decantation.

Whether the double or three-fold acid process has been used, the matter now reaches its final treatment to free it from undesirable material. This will consist principally of sand and perhaps large radiolaria. A little of the clean material is put in a porcelain evaporating dish with a diameter of about 4½ inches, water poured in so as to stir up the mass and the whole rotated in such a way as to give a slight whirling motion to the contents. It is difficult to describe this process, though easy to demonstate it. It may help to render clear the idea of the motion desired by saying that if we imagine an ink spot to be placed on the under side of the evaporating dish exactly in its center, the motion consists in rotating this ink spot around a tiny spot on the table in such a way that the circle of rotation will have a diameter of about a quarter of an inch. The effect of this peculiar motion is to roll the rounded particles of sand and the radiolaria into a little mound at the bottom of the dish, while the diatoms, which are mostly angular or flat, spread out in the water. After the rotation has continued for about a minute, the contents are quickly poured into a clean beaker, taking care that the sand, etc., remain in the dish. Fresh water is now added and the process is repeated until it is found that the residue in the dish is free from diatoms. This sand separation is not always necessary, in fact is never necessary unless

the investigator wishes to have his diatoms as free as possible from extraneous matter.

The thoroughly washed and cleaned material is now put up in bottles in 35 per cent alcohol and properly labeled.

No attempt will here be made to describe the subsequent mounting of clean diatoms. This must be left to the wishes of the investigator, dependent upon whether his purpose is to make strewings of the diatoms or to pick the individuals out and mount them separately. If the latter and of course the better method is used, it may be well to add one or two suggestions. The writer uses special microscope slides for picking out diatoms. The slides selected are thick, about 2 mm. Eleven lines are drawn across the slide near the middle, about 3 mm. apart with a writing diamond, and a median line is drawn across these 11 lines bisecting them, the lines thereby producing 20 spaces. Figures from 1 to 10 are written near the margin of the slide, numbering the 10 cross divisions. One has thereby 20 spaces, upper and lower No. 1, upper and lower No. 2, etc., and in picking diatoms he can proceed in an orderly way from one side to the other, back and forth through the spaces marked by the cross lines; and when a diatom is found and removed for mounting, he is able with this slide to go back to the exact place where he left off by remembering the part of the subdivision where the selection was made. He therefore avoids going over the same ground twice or missing part of the material on the slide.

In making a strewing from which to pick individual diatoms a couple of drops of the clean material well shaken up is placed upon the slide, spread out over the lines by tilting the slide, and the water and alcohol evaporated over a spirit lamp. The diatoms should lie evenly strewn on the slide and be perfectly dry. If the cleaning has been properly done and distilled water and absolute alcohol have been used for the 35 per cent solution, the diatoms should be loose upon the glass and can be picked up with the greatest ease. The only wholly satisfactory way of accomplishing this selecting and mounting of individual diatoms is by means of the apparatus known as the mechanical finger. The method of using this delicate instrument can not be taught by description. It must be demonstrated, and is even then a part of diatom technic which requires long practice. But the result obtained is so superior to diatom specimens in a strewn slide that the learning of this process is strongly recommended. A strewn slide bearing the name of any specific diatom contains many others, and some may be very similar in general appearance. How is the student to pick out the true type from this mass of material, when he probably is looking for an example of the type in order to know how it looks? But if each diatom is mounted separately, it becomes

an ideal herbarium specimen and its value for purposes of identification is great.

There remains the subject of the preparation of fossil diatoms. So-called diatomaceous earth is generally free from organic matter and is only subjected to acid treatment when it contains iron or other substances that can be dissolved out by acids, or especially when it contains calcareous matter. Diatomaceous earth of this last kind is easily disintegrated by treatment with hydrochloric acid; as the lime is thereby dissolved and the mass falls into a powder. But most diatomaceous earth is not so easily handled, being composed entirely of silica remains and often hardened into a stony condition. The breaking up of such samples can not be done by pulverizing, as this would shatter nearly all of the diatoms. The mass must be gently brought into a powdery condition. The best way of accomplishing this is to first break the material up into small pieces about the size of a pea, using for this purpose not a hammer, but a stout needle, which cracks off small particles without breaking many of the diatoms. The pieces having thus been reduced in size are boiled in a beaker with a weak solution of some mild alkali, like sodium carbonate. A solution of borax also sometimes works satisfactorily. The material is boiled until the liquid begins to look milky by the slow breaking away of the diatoms from the lumps. The liquid is then poured into a larger beaker, fresh alkali water added to the lumps, and again boiled. The process is kept up until by this gentle method the lumps are slowly broken down. After the combined boilings poured together have been allowed to settle, the liquid is poured off and the sediment washed by decantation until all trace of the alkali is removed.

In cases of extremely resistent fossil material, where neither hydrochloric acid nor long boiling in weak alkaline solutions breaks down the lumps, this disintegration may sometimes be effected by soaking the lumps in strong sodium carbonate, quickly replacing with hydrochloric acid, returning again to sodium carbonate, and so alternating until the violent chemical reactions set up *within* the lumps by these alternations have mechanically broken them down.

If the repeated washings necessary with any of the foregoing processes are properly timed they will also accomplish the removal of clay or minute broken particles of diatoms that are in the sediment. Where the fossil substance contains sand, the final process of rotating this in an evaporating dish will remove it, as in the case of the living diatom material previously described. The cleaned diatoms are then put up in bottles with 35 per cent alcohol, as in the case of the living material.

It sometimes happens with fossil material, more rarely with fresh, that a fine flocculent residue is mixed with the cleaned diatoms and

persistently resists separation by decanting. It can generally be removed by boiling in some thin colloidal solution, like soap solution, the flocculent matter being thereby held in suspension while the diatoms are settling. By one or two such boilings and careful decantations this silicious floc will be largely or wholly removed. Very careful washing is required after this soap treatment before the diatoms are put away in 35 per cent alcohol.

However the author may have tried to make plain the different steps in preparing diatoms for study, he recognizes that some confusion may exist in the minds of students in regard to some parts of this technic. A letter of inquiry, directed to him at the United States National Museum, Washington, District of Columbia, will receive an answer, in which the points in question will be more carefully explained.

NOTES ON AN ANDORITE-BEARING SILVER ORE FROM NEVADA.

By Earl V. Shannon,

Assistant Curator, Department of Geology, United States National Museum.

INTRODUCTION.

A specimen of rich silver ore recently examined in the laboratory of the United States National Museum proved to consist largely of the rare lead-silver sulphantimonite andorite ($2PbS.Ag_2S.3Sb_2S_3$). This mineral has previously been found at Felsobanya in Hungary, and at Oruro, in Bolivia, but has not heretofore been identified from any locality in North America. The ore is described in some detail below. The specimen came to the Museum from the Centennial Exposition (1876) and was catalogued by former Curator F. P. Dewey (Cat. No. 15,908) as from Mr. M. F. Randolph, Keyser Mine, Morey District, Nye County, Nevada.

DESCRIPTION OF THE ORE.

The andorite ore specimen will average perhaps 1,000 ounces of silver a ton, most of which is in the form of andorite or an alteration product of andorite. As judged from a study of this single specimen the earliest mineralization of the vein was a pale pinkish manganiferous carbonate containing a very small amount of finely divided contemporaneous pyrite. The carbonate filled most of the available open space, except some narrow vugs, which were lined with acute rhombohedral crystals of the rhodochrosite. Later movement resulted in extensive brecciation of the carbonate mineralization followed by the introduction of much granular quartz accompanied by silver minerals, which partly replaced the brecciated carbonate and were deposited in the quartz, and later zinc sulphide, which replaced the quartz. Small open cavities in the quartz are lined by drusy quartz crystals upon which rest very rare grains of pyrargyrite and stephanite. One vug contained a crystal of selenite gypsum as the last mineral deposited.

DESCRIPTION OF THE ANDORITE.

The andorite forms prismatic grains which are apparently contemporaneous with the quartz and range from pure andorite to

andorite-quartz intergrowths or andorite shells inclosing a large amount of quartz. The prisms, which have ragged edges, reach an extreme length of 1.5 cm. with a width of 4 mm. They lie disseminated in the granular quartz like phenocrysts in a porphyry and show no regularity of arrangement. The associated sphalerite, which is dark brown with well developed cleavage, forms rounded grains up to 1 mm. in diameter disseminated in the quartz between the andorite prisms. These are apparently replacements of the quartz and while grains of sphalerite occasionally have a core of andorite the andorite never incloses sphalerite. The sphalerite shows a purple-gray color and metallic luster on polished surfaces. The andorite has a brilliant metallic luster and light lead-gray color. It is devoid of cleavage and has a conchoidal fracture when unaltered. The hardness is about 2.5 and on unglazed porcelain the mineral yields a soft dull black streak which when rubbed with a glass rod becomes first shining and then decidedly brown. The mineral assumes a yellowish tarnish upon exposure. Material was hand picked for analysis, care being used to avoid, as far as possible, the material showing the alteration described below. The analyzed sample contained some quartz and also a little sphalerite, the latter mineral being recognized as isotropic dark brown grains when the analyzed powder was examined under the microscope. Insoluble quartz deducted, the analysis yielded the following percentages:

Analysis of andorite from Nevada.

Lead (Pb)	23.35
Silver (Ag)	12.09
Iron (Fe)	1.55
Zinc (Zn)	3.56
Antimony (Sb)	37.64
Sulphur (S)	22.63
Total	100.82

Of the above tabulated constituents zinc is certainly foreign and present as sphalerite and it seems most reasonable to consider the iron as also extraneous and associated with the zinc sulphide as an impurity. These metals deducted, the analysis furnishes the following ratios:

Ratios of andorite from Nevada.

Pb	0.1127	11.27	1.13 x 1	1.09 x 1
Ag	.1121	11.21	1.12 x 1	1.08 x 1
Sb	.3131	31.31	1.04 x 3	1.00 x 3
S	.7057	70.57	1.01 x 7	.97 x 7

These ratios indicate closely the andorite formula:

$$PbAgSb_3S_7 \text{ or } 2PbS.Ag_2S.3Sb_2S_3.$$

The results in percentages of the essential constituents are below recalculated to 100 per cent and compared with the theoretical percentages to suit the andorite formula:

	Original.	Recalculated.	Theory.
Lead	23.35	25.06	23.87
Silver	12.09	12.98	12.45
Antimony	37.64	40.41	41.49
Sulphur	20.08	21.55	22.19
Total	93.16	100.00	100.00

This comparison shows that, while the mineral agrees in all essential respects with andorite, it is slightly high in lead sulphide and correspondingly low in silver and antimony. This may be due to incipient alteration along the lines discussed below.

The andorite gives, before the blowpipe, the usual reactions for silver, lead, antimony, and sulphur. In the closed tube it decrepitates slightly and fuses at a moderate temperature but without conspicuous decomposition, yielding faintly perceptible rings of sulphur and antimony oxide, oxysulphide, and sulphide. In the open tube it gives a copious sublimate of antimony oxide. The mineral is soluble in hot concentrated hydrochloric acid.

ALTERATION OF THE ANDORITE.

While andorite was originally the most abundant metallic mineral of the ore, typical unaltered andorite crystals are now rare, the majority of the individuals being more or less affected by a change which is first manifested by a granular appearance and prismatic cleavage or parting. With further alteration a porous core is developed in the andorite mass with a brilliant blue or purple tarnish. In extreme stages of alteration the andorite contains a central cavity filled with finely felted wool-like material or is replaced entirely by stellar aggregates of fine fibers. Partial analyses indicate that crystals in the first stages of the alteration which have been dulled in luster with the development of granular or subfibrous appearance and prismatic parting do not differ greatly in composition from the unaltered andorite. Two partial analyses of materials showing these changes in properties gave the following results:

Analyses of partly altered andorite.

	1.	2.
Lead	25.54	27.86
Silver	13.35	12.12
Antimony	36.38	38.06

The only noteworthy change is a slight increase in the relative amount of lead, which apparently increases gradually as the alteration proceeds. The end product of the alteration is the fine fibrous material which is present in small amount in pure form. One completely altered crystal was carefully analyzed, although there was only 0.0771 grams of the material for analysis. This yielded the following composition:

Analysis of completely altered andorite.

Lead	45.14
Iron	2.72
Zinc	1.56
Silver	7.78
Antimony	23.22
Sulphur (calculated)	19.58
Total	100.00

This analysis yields the following ratios:

Ratios of altered andorite.

Lead	0.2178		
Iron	.0487	0.2904	1.04 x 8
Zinc	.0239		
Silver	.0721	.0721	1.03 x 2
Antimony	.1932	.1932	.93 x 6
Sulphur	.6105	.6105	.97 x 18

Unfortunately, the homogeneity of the small amount of material analyzed was not demonstrable. Assuming that the above analysis represents a homogeneous mineral, the formula yielded by the ratios is:

$$8(Pb,FeZn)S.Ag_2S.3Sb_2S_3.$$

Separating Fe plus Zn from lead, this becomes:

$$6PbS.2(Fe,Zn)S.Ag_2S.3Sb_2S_3, \text{ or}$$
$$Pb_3(Fe.Zn)AgSb_3S_9.$$

Such a formula would fall in the 3:1 division of Foshag and Wherry and in the bournonite group. However, since iron and zinc were rejected as extraneous constituents of the original andorite, it seems reasonable to likewise reject them here, the formula then becoming:

$$6PbS.Ag_2S.3Sb_2S_3 \text{ or } Pb_3AgSb_3S_8.$$

This formula falls in the 7:3 division, diaphorite group of Wherry and Foshag. While it is probable that a new mineral is here represented, the evidence does not justify the assigning of a new name. A comparison of the last given formula with that of the unaltered andorite brings out the fact that in the process of alteration the ratio of silver to antimony has not changed, while the relative amount of

lead has greatly increased. The fact that the alteration has resulted in a great decrease in volume shows that the alteration has been by the removal of silver and antimony rather than by the addition of lead. There is nothing to indicate that this change is the result of surficial weathering or any attendant process. Apparently all of the constituents of this ore are primary and the ore has not been affected by secondary downward sulphide enrichment. It would seem that the andorite, stable under the conditions under which it was formed, became unstable under conditions obtaining later in the history of the vein and broke down, a part of the silver and antimony being removed as sulphides. The loss of silver and antimonial sulphides has been in the same ratio to each other in which they are present in the original mineral, namely, $Ag_2S.3Sb_2S_3$. No simple silver sulphantimonite of these ratios is known.

THE GANGUE CARBONATE.

The carbonate, which forms the earliest mineral of the ore, is pale-pinkish buff (Ridgway) in color and is finely granular, except where it lined open cavities, where it formed crusts of small crystals. The material is brecciated, and some fragments which are isolated in the quartz are largely replaced by finely-divided metallic sulphides. These are too small for their identity to be definitely determined without microscopic study of polished surfaces in reflected light, but it is probable that the grains are mostly andorite and sphalerite. Small fragments of the carbonate were selected free from admixed minerals and analyzed with the following results:

Analysis of rhodochrosite from Nevada.

MnO	49.49
FeO	7.68
CaO	3.13
MgO	.93
CO_2 (calculated)	38.87
Total	100.10

Stated as carbonates of the respective bases this analysis gives:

$MnCO_3$	80.15
$FeCO_3$	12.39
$CaCO_3$	5.59
$MgCO_3$	1.97
Total	100.10

This is, as is to be expected, a relatively pure rhodochrosite. Such highly manganiferous carbonates are very frequent as gangue minerals in hydrothermal silver veins. The significance of this association will be further discussed in a paper which is in preparation.

SYNOPSIS OF THE NORTH AMERICAN FLIES OF THE GENUS TACHYTRECHUS.

By Charles T. Greene,

Of the Bureau of Entomology, United States Department of Agriculture.

INTRODUCTION.

This synopsis is based entirely on the type material and all the types have been examined by the author. The location of the type is designated under each species.

I wish to acknowledge my thanks to Dr. J. M. Aldrich for his helpful criticism and suggestions and record his generous gift of material from his collection to the national collection. To Mr. Nathan Banks for making some additional comparisons at the Museum of Comparative Zoology, Cambridge, Massachusetts. To Mr. M. C. Van Duzee for the gift and loan of material, and to Mr. H. S. Harbeck for the gift of some specimens.

The types of all the new species are deposited in the United States National Museum.

HISTORICAL OUTLINE OF THE GENUS.

The genus *Ammobatės* was established by Stannius in 1831 [1] with the three species *plumipes*, *notatus*, and *insignis*, all new. Haliday in 1851 changed the name to *Tachytrechus* [2] on account of the preoccupation of *Ammobates.* Coquillett in 1910 [3] designated *Ammobates notatus* Stannius as the type.

In 1878 Mik[4] divided the genus into two genera by the following characters:

Male antennae normal, like those of the female; fourth longitudinal vein ending just before the extreme apex, at a considerable distance from the tip of the third---Tachytrechus.

[1] Isis von Oken, 1831, Heft 1, pp. 33, 268.

[2] Idem, p. 261. *Tachytrechus* Stannius is a *nomen nudum.*

[3] Type-species of the North American Diptera, Proc. U. S. Nat. Mus., 1910, vol. 37, p. 611.

[4] Dipterologische Untersuchungen, 1878, p. 3.

Male antennae with the second joint rudimentary and the arista elongated and ending in a lamella; fourth vein ending considerably before the apex, very close to the tip of the third vein---------------------------Macellocerus.

The common or general characters of *Tachytrechus* are as follows: First antennal joint hairy above, arista dorsal, face long, narrow, wider below and with the tip rounded, reaching as low as the inferior border of the eye; wings narrow, in the male especially, but rather broad in one species [*T. rotundipennis*]; hypopygium of the male entirely disengaged, directed forward under the venter, reaching nearly to the coxae; hind metatarsi without bristles above.

The characters used by Mik to separate *Macellocerus* from *Tachytrechus* were mostly male characters. After a careful study of the two genera I consider them to be one genus, although the males do divide satisfactorily into two groups by the antennae.

The genus divides naturally into three groups on the male characters: 1, wing with a maculation at the apex; 2, arista very long with a lamella at the tip; wing without maculation; 3, arista short and normal; wing without maculation.

Genus TACHYTRECHUS Haliday.

Key to the males.

1. Wing with a black spot at the apex-------------------------------------2.
   Wing without a spot---6.
2. Spot large, round with a very narrow hyaline border around the lower edge; no snow-white spot---------------------------No. 4. floridensis Aldrich
   Spot black with a snow-white spot behind it----------------------------3.
3. White spot nearly equal in size to the black spot-----------------------4.
   White spot much smaller than the black spot---------------------------5.
4. White spot at apex of wing, rounded and nearly equal in size to the black one; wing narrow and pointed------------------------No. 3. vorax Loew.
   White spot like a half crescent; black spot very large and rounded; wing very broad and rounded---------------No. 2. rotundipennis, new species.
5. Black spot long, narrow and pointed below; white spot very long and narrow-----------------------------------No. 1. simulatus, new species.
   Black spot large; white spot very small and hemispherical.
   No. 5. volitans Melander.
6. Arista short, normal, no lamella---------------------------------------7.
   Arista very long, with a terminal lamella-------------------------------9.
7. Hind tibiae with two or three flattened bristles on the posterior side.
   No. 15. angustipennis Loew.
   Hind tibiae without such bristles---------------------------------------8.
8. Middle tarsus with the second joint extremely broad, flattened, tarsus conspicuously ornamented----------------No. 14. granditarsus, new species.
   Middle tarsus normal, except the third joint is slightly bent.
   No. 16. protervus Melander.
9. Arista with a lamella at the apex and another in the middle.
   No. 6. binodatus Loew.
   Arista with a lamella at the apex only---------------------------------10.

10. Femora entirely yellow ---- 11.
   Femora black or yellow with blackish infuscations ---- 14.
11. Front femora with long crinkly or straight hairs ---- 12.
   Front femora without long hairs ---- 13.
12. Front femora with long crinkly hairs on the outside surface.
   No. 11. **auratus** Aldrich.
   Front femora with long straight hair on the under side.
   No. 7. **bipunctatus**, new species.
13. Femora and tibiae entirely yellow; middle tibae with three or four large macrochaetae on the apical half of the inner flexor side; also a row of large bristly hairs the entire length of the outer flexor side.
   No. 8. **tenuiseta**, new species.
   All femora yellow; hind tibiae yellow with a blackish infuscation at the tip; arista slightly longer than height of head, lamella large and rounded.
   No. 12. **moechus** Loew.
14. Front femora yellow, very much enlarged on basal half; with a large brownish-black spot on the outside ---- No. 10. **olympiae** Aldrich.
   Front femora normal ---- 15.
15. Front femora yellow; middle and hind femora faintly blackish at the base; middle tibiae with one large macrochaeta on inner flexor side near the apex ---- No. 13. **sanus** Osten Sacken.
   All femora greenish black; front tibae pale yellow; extremely broad on apical two-thirds; with a row of black, flat bristles on flexor side.
   No. 9. **laticrus** Van Duzee.

Key to the Females.

1. Wing with an apical cloud ---- No. 1. **simulatus**, new species.
   Wing without any cloud ---- 2.
2. Antennae entirely black ---- 3.
   Antennae black and yellow ---- 7.
3. Legs black ---- 4.
   Legs mostly gray or yellow ---- 5.
4. Front tibiae with four extremely long macrochaetae on outer flexor side; hind femora with a bronze reflection ---- No. 2. **rotundipennis**, new species.
   Front tibiae with two small macrochaetae on outer flexor side; hind femora with a green reflection ---- No. 15. **angustipennis** Loew.
5. Legs with red or yellow markings ---- 6.
   Legs without any red markings ---- No. 4. **floridensis** Aldrich.
6. Legs mostly pale yellow with only small blackish infuscations.
   No. 5. **volitans** Melander.
   Legs mostly reddish-yellow ---- 7.
7. Hind femora black with silver and green reflections; apical third reddish-yellow; hind tibiae reddish-yellow with apex blackish. Species with a bright green or red reflection (western) ---- No. 14. **granditarsus**, new species.
   Hind femora the same as above with only the apices reddish-yellow; bronze species ---- No. 3. **vorax** Loew.
   Characters not as above ---- 8.
8. First antennal joint entirely yellow ---- 9.
   First antennal joint infuscated above ---- 10.
9. Femora entirely yellow ---- No. 11. **auratus** Aldrich.
   Femora entirely black ---- No. 9. **laticrus** Van Duzee.
   Femora black with apical third yellow ---- No. 13. **sanus**. Osten. Sacken.

10. Front tibiae with three extremely long macrochaetae on the outer flexor side__________No. 16. **protervus** Melander.
    Front tibiae with a row of short bristles near the outer flexor side. No. 8. **tenuiseta**, new species.
    Front tibiae not as above__________11.
11. Femora mostly yellow with gray or black markings__________12.
    Femora mostly blackish or red__________13.
12. Front femora with a gray spot on the outside near the base; front coxae ashen gray in front__________No. 7. **bipunctatus**, new species.
    Front femora with a gray spot on the underside near the base; front coxae yellow in front at the apex__________No. 10. **olympiae** Aldrich.
13. Hind femora reddish-yellow with a deep infuscation from base to apex; posterior cross-vein deeply bowed in center__________No. 6. **binodatus** Loew.
    Hind femora paler yellow with an infuscation on basal two thirds only; posterior cross-vein nearly straight__________No. 12. **moechus** Loew.

1. TACHYTRECHUS SIMULATUS, new species.

Figs. 5, 6.

Male.—Face twice as wide on lower part as it is immediately below the antennae; face stops far short of lower edge of eyes; a very narrow green stripe in center, balance of face heavily coated with brown dust, dull; front dark green dusted with grayish-white around the sides; ocellar triangle black, ocelli yellow. Orbital cilia and mouth parts black. Antennae black, each of the three joints of nearly equal length, first joint beset with black hairs above; arista pale on apical half gradually thickened on lower half toward base. Orbital cilia black. Thorax and scutellum green with a bronze and white pruinose reflection according to the position in the light. Abdomen bright green with a white pruinosity. Hypopygium large, black with dark red areas on the side, black areas with a whitish pruinosity; lamellae slightly triangular, brown black, cilia black. Legs coated with a whitish dust the entire length, femora green, knees reddish-yellow; tibiae and tarsi darker reddish-yellow, a slight infuscation at apex of tibiae and on the tarsal joints. Wings broadly rounded at apex (much broader than in *vorax*) large black dot in the apex, most of which is behind the fourth vein and the dot is decidedly pointed behind, tip of wing has a long, narrow, snow-white spot; tegulae deep yellow, cilia long and black; halteres deep yellow, slightly infuscated at base.

Length 5 mm.

Female.—Like the male except it is slightly more robust; face and front slightly paler; wings with a small brownish cloud at the apex. This is the only female in the genus with a wing maculation.

Type locality.—St. Anthony, Idaho, July 16, Dr. J. M. Aldrich, collector.

Described from three males and one female.

Type, Male.—Allotype, female, Cat. No. 24130, U.S.N.M.

A male and the female from Nanaimo, British Columbia Biological Station, June 25–28, 1920; E. P. Van Duzee, collector. Two males returned to the California Academy of Sciences.

Allied to *vorax* but is easily separated from this species by the shape of the wing and the apical spot; the face being much shorter; color of the face and front and the abdomen being bright green instead of bronze.

2. TACHYTRECHUS ROTUNDIPENNIS, new species.

Fig. 2.

Male.—Face twice as wide on lower part as immediately below the antenna; face stops far short of lower edge of eyes and it is heavily coated with a golden yellow dust, dull; front dark green dusted with dark brown around the sides; ocellar triangle blackish, ocelli reddish. Orbital cilia black on apical half, white on lower half. Mouth parts brownish black. Antennae black, first joint about three-fourths the length of the second and third together, beset with short black hairs above; arista black and thickened gradually on the basal half. Thorax and scutellum bronze green with dark-brown dust, sides of thorax bronze heavily dusted with white. Abdominal segments broadly green at their bases and dusted with white, especially on each side; at the apex of each segment is a dark, bare, bronze area. Hypopygium large, dusted with yellowish-white except a small area on each side at apex; lamellae large, about three times as long as wide, brown black, cilia black, quite long on outer edge. Femora dark bronze green coated with a white dust, apex of fore and middle pair broadly, hind pair more narrowly yellow; all tibiae yellow, apices of tibiae and entire tarsi infuscated with reddish brown. Wings very broadly rounded on the apical half and with a slight indentation of the margin at the fifth vein. A large round, black dot at tip of wing, bisected by the fourth vein, behind this is a smaller white dot somewhat triangular in form; tegulae pale yellow with long black cilia; halteres deep yellow, slightly darker at base.

Female.—Like the male except the wing does not have the spots.

Length 5 mm.

Type locality.—" Delaware VIII " (no other data), from Dr. J. M. Aldrich.

Described from two males and two females.

Type, male.—*Allotype*, female and two paratypes. Cat. No. 24131, U. S. N. M.

One male and two females from Manahawkin, New Jersey, September 5, 1910; H. S. Harbeck, collector.

Allied to *T. simulatus* Greene, but easily separated from that species by the very broad wing, the shape of the spots at the apex of the wing and the color of the orbital cilia.

3. TACHYTRECHUS VORAX Loew.

Fig. 1.

Tachytrechus vorax Loew, Neue Beitraege, 1857, vol. 8, p. 41.

Male.—Face reaching lower edge of eyes, upper portion about three-fourths as wide as the lower, covered with a dull, yellowish dust; front a velvety brown. Antennae entirely black; first joint nearly equal in length to the other two, enlarged towards the apex, having a thumblike projection on the inside at the apex; second joint not quite so long; third joint rounded on outer edges. Arista black, bare and thickened on the basal third. Orbital cilia black above, white below. Thorax on upper side with a gray-yellowish or brownish-yellow dust upon a metallic-green or partially copper-colored and lustrous ground, very dull. Abdomen green and coppery, dull, with a gray-whitish dust. Hypopygium black, upon the inferior side more greenish-black, but gray from a pale dust; lamellae black, moderate size, slightly rounded, covered with black hairs. Femora dark metallic-green, thinly pruinose with whitish dust, tip brownish-yellow; tip of the fore and hind tibiae blackened, tip of middle tibiae usually only brown. Tarsi black, plain, fore tarsi usually brownish-yellow only at the extreme root, middle tarsi brownish-yellow upon the first half of the first joint. Wings narrow, large black spot nearly bisected by the fourth vein, behind this spot is one of snow white covering the extreme apex of the wing, and nearly equal size; halteres infuscated with brown, tegulae pale yellow with long black cilia.

Female.—Face and front pale silvery yellow, dull, face slightly broader than in the male. Abdomen more greenish. Yellow of the legs more reddish. Wing without spot, slightly tinged with brown and more rounded at the apex.

Length 5–6 mm.

Type locality.—District of Columbia.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

Distribution.—Lafayette, Indiana, May 27, 1915, to July 27, J. M. Aldrich; Boulder, Colorado; Franconia, New Hampshire; Battle Creek, Michigan; Chesterton, Indiana, June 2, 1916, J. M. Aldrich; Michigan City, Indiana; Santa Monica, California, July 31, 1911; Brookings, South Dakota, Westville, New Jersey, August 18, C. W. Johnson; Barcroft, Virginia, and Avalon, New Jersey, August 8, 1909, C. T. Greene; Trenton, New Jersey, August 7, 1910, H. S. Harbeck.

4. TACHYTRECHUS FLORIDENSIS Aldrich.

Fig. 4.

Tachytrechus floridensis ALDRICH, Trans. Amer. Ent. Soc., 1896, vol. 23, p. 82.

Male.—Face silvery white, nearly twice as wide on the lower part as it is immediately below the antennae. Front greenish, heavily coated with a whitish dust. Antennae black, first and second joint a little elongated; third joint rounded. Arista black, slightly longer than the antennae. Orbital cilia mostly white, just a few black bristles above. Thorax green, heavily coated with a white dust around the sides, more of a brownish in the center. In some lights the green ground color is quite visible. Just above the root of the wing is a dark brown spot. Scutellum green with a coating of golden brown dust. Abdomen metallic green heavily coated with a white dust; down the center of the dorsum and along the apical edge of each segment more shining, near the apical edge of each segment is a transverse row of large black bristles. Hypopygium large, first joint small, next joint large and globular, covered with a whitish dust and fine black hairs, lower edges shiny reddish-black; lamellae nearly black, somewhat triangular; the outer lower edge rounded and with long black hairs. All the coxae dark with a silvery dust. Front and hind femora on their basal two-thirds and the middle pair on slightly more than their basal half, greenish covered with a silvery dust; tibiae reddish-yellow with brownish tips and all tarsi dark brown. Wings hyaline, slender, rounded at tip with a large, round blackish brown spot at apex; this spot extends narrowly before the third vein and is separated from the posterior edge of the wing by a very narrow hyaline margin. Posterior cross vein straight. Halteres pale yellow. Tegulae pale yellow with long black cilia.

Female.—Very much like the male except as follows: Face only slightly wider. Antennae a little shorter. Wings not quite so narrow and without the apical spot. On the outside of the fore tibiae there are one or two small black bristles in a third series.

Length 5 mm.

Type locality.—Florida, F. H. Snow, collector.

Cotype, male and female.—Cat. No. 24140, U.S.N.M. Deposited by J. M. Aldrich in United States National Museum collection. Originally described from two males and two females, labeled "Fla."

One specimen, a male, from Biscayne Bay, Florida, Mrs. Slosson, collector. In United States National Museum.

5. TACHYTRECHUS VOLITANS Melander.

Fig. 3.

Tachytrechus volitans MELANDER, Can. Ent., 1900, vol. 32, p. 143, fig. 8.

Face broad, dull, pale yellow (in certain lights pale golden), wider below, narrower above (just below the antennae). Front dull,

dark velvety brown; ocellar triangle slightly darker, dull brown. First two joints of antennae blackish; first joint when viewed from behind, brownish; when viewed from in front, opaque-black, except inner projection; about one and one-half times the length of the second; third joint missing. Thorax with the ground color of brilliant metallic copper-color, shining through a thick coating of brown dust; a broad central stripe shining; sides with a pale brown and in certain lights with a nearly white pruinosity. Abdomen deep bronze, sides reddish broadly though lightly dusted with a whitish pruinosity. Hypopygium large, black; stem short and fairly thick; lamellae dull black with longer hairs on the outer edge. Legs mostly bronze blackish with whitish pruinosity; tips of all tibiae and tarsi black (except base of metatarsi). Tips of all femora, greater part of the tibiae and base of metatarsi faintly reddish yellow. Front coxae half as long as the front femora and about twice as thick as same. Pulvilli relatively longer than in *floridensis*, snow-white. Wing with a large black spot at apex, touching the third vein in front and bisected by the fourth; a small, hemispherical, snow-white spot behind at the tip of the wing. Halteres deep brownish yellow on the knobs, base of stem nearly black.

Female.—Very much like the male except as follows: Wing entirely hyaline. General color of body and dark portions of the legs more greenish. Central stripe of thorax not polished, nearly as dull as the sides. Abdomen more greenish and with more white pruinosity. Legs paler yellow, this color more noticeable than the black.

The male is labeled "12 m. N. W. of Lusk, Wyo. July, '95; U. of K. Lot 428; Type; W. M. Wheeler, collection." The female labeled the same except Lot 430. Both specimens in the collection of the American Museum of Natural History, New York City.

6. TACHYTRECHUS BINODATUS Loew.

Fig. 14.

Tachytrechus binodatus LOEW, Centuries, 1861, pt. 7, No. 84, p. 106.
Macellocerus binodatus LOEW, Trans. Amer. Ent. Soc., 1896, vol. 23, p. 83.

Male.—Face about as long as the eye; dull golden-yellow; just below antennae about half as wide as at lower end. Front bronze green, not very shiny. Ocelli yellowish. Antennae mostly bright yellow; first joint swollen at apex, nearly as wide at apex as it is long, black, bristly hairs above; second joint quite small and rudimentary; third joint slightly rounded, mostly brownish-black, a little yellow along the base. Arista mostly black, slightly swollen at base, a lamella in the middle and another at the tip; the outer half of the stem and the base of the apical lamella white. Orbital cilia black above and whitish below. Thorax and scutellum bronze-green covered with a brown dust; two velvety black spots in front of the base of the wings, the anterior spot not very distinct. Abdomen more brassy-green coated

with a yellowish-white dust; apical edge of each segment narrowly brownish-black. Hypopygium large, brassy or bluish-green coated with a yellowish-white dust; lower edges shiny, black to reddish; lamellae brown, yellowish at base, hairs brownish-black. On the outer lower corner is a finger-like projection. Front coxae yellow, gray on underside; middle and hind ones grayish-black. Legs and base of all metatarsi yellowish at the base. Tips of fore and hind tibia, bases of the middle and hind femora and the remainder of the tarsi blackish-brown. Front femora decidedly broadened on the basal two-thirds, on the inner side is a large, elliptical bare spot. Wings faintly tinged with brown, edge faintly curved inward before and after the fifth vein; posterior cross-vein with a deep bend in the middle. Halteres pale yellow. Tegulae pale yellow, fringes long and black.

Female.—Very much like the male except darker in color and more robust. Face wider, silvery. Front grayish-brown with a whitish dust. Antennae shorter, third joint with more reddish-yellow. Arista black, about three-fourths as long as face, thickened on the basal third. Apical end of fore and middle femora, outer surface of hind femora, basal fifth of middle and hind tibiae, fore tibiae except apical end, and basal half of all the metatarsi reddish-yellow; balance of the legs infuscated with dark brown. All legs dusted lightly with a whitish dust. Wings faintly tinged with brown, broader and not so deeply incised on posterior edge. Posterior cross-vein deeply but more broadly arcuate.

Length 5 mm.

Type-locality.—Saratoga, New York, Osten Sacken.

Type.—In the Museum of Comparative Zoology, Cambridge, Massachusetts.

Distribution.—Battle Creek, Michigan; Ira, Summit County, Ohio, September 10, 1894; Lafayette, Indiana, May 22, 1915. Four specimens deposited in United States National Museum Collection by J. M. Aldrich. Durham Pond, Morris County, New Jersey, August 18, 1901, George M. Greene, collector.

7. TACHYTRECHUS BIPUNCTATUS, new species.

Figs. 13, 18.

Male.—Face twice as wide at each end as it is about one-third the distance below the antennae, densely coated with a yellow dust, dull and slightly shorter than length of eyes. Front deep green, in certain lights with a dark brown area in middle; ocellar triangle dark green, ocelli very pale yellow. Antennae mostly yellow, first joint quite large, twice the length of the third, slightly infuscated at tip; second joint very rudimentary, third joint somewhat rounded, brown-black

except the base and lower corner which is yellow. Arista longer than the face, black, thickened at base only, lamellae black, elliptical, with a white elliptical spot on upper edge at the base. Thorax and scutellum dark green bronze with a dark brown dust. Abdomen a lighter, brassy green, coated with a golden brown dust. Hypopygium large, pedicel whittish pruinose on upper side with a greenish reflection in certain lights and slightly corrugated, shiny reddish-black below, second joint from the side, triangular with whitish pruinosity and long black hairs, last joint very large, heavily pruinose, basally with a lavender tint, otherwise pale green with two smoother black dots in the center, lower portion on the sides shiny reddish-black, lamellae broad, pale yellow with long black hairs. Legs all yellow except extreme tips of middle and hind tibiae and all tarsi, blackish. Front femora with long, straight black hairs on lower side. Wings slender, faintly tinged with brown; tegulae pale yellow with long black cilia; halteres pale yellow.

Female.—Very similar except the general color is slightly darker. Face is more silvery, antennae shorter, third joint all black except a very small area at lower corner, arista normal, not quite as long as the face and brown in color, darker at the base. Orbital cilia whitish close to the oral margin. Legs more reddish, apical two-thirds of front tibiae blackish; front coxae and a large spot on under side of front femora, at the base, silvery gray. Infuscation on the tibiae extends more on apical half, but is much darker on apical fourth.

Length, 6 mm.

Type locality.—St. Anthony, Idaho. Dr. J. M. Aldrich, collector.

Described from three males and one female. Two males and the female from St. Anthony, Idaho, July 16, 1900, and a male from Soda Spring, Idaho, June, 1900, J. M. Aldrich, collector.

Type, male.—*Allotype*, female, and two paratypes. Cat. No. 24132, U.S.N.M.

Closely allied to *T. auratus* Aldrich, but easily separated by the straight hairs on the front femora, the size of the antennae, the small lamella of the arista and the hypopygium has two small dark spots. This species is also larger in size than *auratus.*

8. TACHYTRECHUS TENUISETA, new species.

Fig. 10.

Male.—Face just above the middle about one-third to one-half the width of the lower part and heavily coated with a golden brown dust; front deep green, not very shiny, ocellar triangle black, ocelli pale yellow. Orbital cilia and mouth parts black. Antennae entirely yellow; first joint about twice the length of two and three together; this joint has a thumblike projection on the inside near the apex; second joint rudimentary; third joint quite short and

rounded. Arista about twice the length of the head; lamellae rounded at tip, tapering down to a point at the base, and below this is a snow-white area nearly as long as the lamella; stem black, very slender and slightly thickened at extreme base. Thorax and scutellum very dark green with brown dustlike reflections in certain lights; scutellum dark green. Abdomen brighter green in certain lights, blackish along apical edge and very broadly silvery-white pollinose on basal three-fourths. Hypopygium large, yellowish at base, whitish in center and blue green on apical third, the edge and projecting parts reddish-black and heavily chitinous; lamella yellow, somewhat triangular in shape, fringe brown. Femora, tibiae, and basal three-fourths of middle metatarsi yellow, rest of middle tarsus and all of hind tarsus brownish; front tarsi all yellow with silvery pruinosity, but in certain lights it is slightly infuscated above with brown. Front tibia has a row of black macrochaetae on the front and side; between these two rows is a row of fine, short, bristly hairs, and two or three large macrochaetae near the base. Wings very faintly tinged with brown on apical half; tegulae whitish yellow with long black fringe; halteres yellow; stems slightly brownish on base.

Female.—Very much like the male, except the following points: Face immediately below the antennae nearly as broad as the lower part, heavily coated with silvery dust, slightly shorter than the length of eye. Antennae little darker, third joint nearly all black, reddish along lower basal edge. Arista normal, about as long as face. Legs deep brown, except apical third of all femora and basal half of all tibiae reddish yellow; all femora with a deep greenish reflection.

Length, 4–5 mm.

Type locality.—Newport, Oregon, August 12, 1902; J. M. Aldrich, collector.

Described from two males and eight females.

Type, male.—*Allotype*, female and three paratypes. Cat. No. 24133, U.S.N.M.

Allied to *T. sanus*, but is easily separated by the difference of the antennae, arista, hypopygium, and the bristles of the front tibia. In *sanus* the middle row of bristly hairs are longer and the two or three macrochaetae at the base are absent.

9. TACHYTRECHUS LATICRUS Van Duzee.[5]

Figs. 15, 17.

Tachytrechus laticrus VAN DUZEE, Ent. News, 1918, p. 46.

Male.—Face as long as the eye height, golden yellow, dull, just below the antennae about one-third as wide as the lower part. Front

[5] This species was first identified by D. W. Coquillett, but the description was never published.

dull, blackish, covered with a little yellowish dust. Antennae entirely light yellow and short; first joint swollen at apex, nearly equal to the length, short bristly hairs on upper side at apex only; second joint quite rudimentary; third joint slightly rounded. Arista about as long as the face, entirely black. About the basal fifth is straight. at the end of this fifth it appearcs to be broken or bent and from here it tapers on to a very thin stem; at the apex is a small elliptical lamella pointed at the tip. Orbital cilia black. Thorax mostly blackish, covered with a dark-brown pollen. There is a bluish-green area covered with a white pollen reaching from one wing around the edge to the other wing. This area is broken by a brown stripe in the middle of the front edge of the thorax. The posterior corners of the thorax are flattened and covered with a white pollen, just above each of these spots is a small area, somewhat triangular, covered with a silvery dust. On the side of the thorax opposite the root of the wing is a large, velvety black spot. Scutellum metallic black with just a little brown dust. Abdomen metallic greenish black with considerable whitish pollen, especially on the sides and at the base. Hypopygium large, black, shining on the inner side, covered with whitish pollen on the outer surface; lamellae nearly round, black, fringed with black hairs, inner appendages shining black. Coxae black with white pollen, fore coxae with yellow pollen and black hairs and bristles on the front surface; femora deep metallic green, dusted lightly with a whitish dust; tips of all femora, middle tibia except apical fourth, basal three-fourths of middle metatarsus reddish-yellow; hind tibiae, tarsi, tips of middle tibiae, tips of fore and middle metatarsi, the last four joints of the fore and middle tarsi reddish-black; front tibia pale yellow, very broad on the apical two-thirds, the lower edge with a series of broad, flat bristles decreasing in size toward the apex. Basal three-fourths of front metatarsus pale yellow. Wings grayish hyaline, costal vein greatly thickened near the base; halteres reddish-yellow. Tegulae pale yellow with black cilia.

Female.—Very much like the male. Face wider, silvery. Antennae normal, artista short about three-fourths as long as face. Legs mostly greenish-black, front tibiae normal; tibiae yellowish except towards the tip; base of metatarsi yellowish.

Type locality.—Manahawkin, New Jersey, May 30, 1910–July 31, 1912, H. S. Harbeck, collector.

Four specimens deposited in the United States National Museum by J. M. Aldrich.

Type.—In collection of M. C. Van Duzee.

10. TACHYTRECHUS OLYMPIAE Aldrich.

Figs. 7, 9, 19.

Macelloceras olympiae ALDRICH, Trans. Amer. Ent. Soc., 1896, vol. 23, p. 83.

Male.—Face not quite as long as eye height, dull yellow, just below antennae, about half as wide as at lower end. Front deep, bronze green, dull. Antennae mostly reddish-yellow, first joint swollen towards tip and about two and one-half times the length of the second and third joints together, black bristly hairs above; second joint quite rudimentary; third joint blackened except at the base. Arista about one and one-third times the height of head, white, base thickened and blackish, lamella black, rounded at apex and the lower point white· Orbital cilia black above, whitish below, an evenly arranged lot of white bristles in the middle of the orbital cilia. Thorax bronze-green, with two small velvety black spots in front of the wing base. Abdomen bronze-green with a whitish dust. Hypopygium large, basal part shining black, central segment bronze-green behind, lamellae whitish, covered with black hairs, those of the margin hardly coarser. Legs mostly yellow, tarsi brownish-black, in certain lights silvery dusted. Front coxae yellow blackish at base; middle and hind coxae with golden dust, hind pair with silvery. Front femur very broad on basal two-thirds, with a large blackish-brown spot on the outside. Wings narrow and slightly brownish. Halteres yellow. Tegulae pale yellow, fringe black.

Female.—All the body colors darker. Face wider, greenish-yellow. Antennae shorter, third joint black, faintly reddish at base. All coxae black; femora more or less dark on the basal part, front femora not swollen but with a gray, silvery area on outside near the base, the hind ones black-green except the apical half or third; tibiae black on the apical third or fourth. Wings longer and much wider than in the male.

Lenth 6 mm.

Type locality.—Olympia, Washington (Trevor Kincaid), June 3 and July 1, 1894.

Distribution.—Corvalis, Oregon, August 15, 1902; Longmire Springs, Mount Rainier, Washington, August 2, 1905; Algonquin, Illinois, May 24, 1895; Keyport, Washington, August 7, 1905; Potlatch, Idaho, June 20, 1907; Mono Lake, California, July 22, 1911; Owen's Lake, California, July 27, 1911; Pacific Grove, California, May, 1906.

Two cotypes (Cat. No. 24783, U.S.N.M.) and six specimens deposited in United States National Museum Collection by J. M. Aldrich. Originally described from two males and two females (cotypes).

11. TACHYTRECHUS AURATUS Aldrich.

Fig. 8.

Macelloccrus auratus Aldrich, Trans. Amer. Ent. Soc., 1896, vol. 23, p. 83.

Male.—Face slightly longer than height of eye, just below the antennae nearly half as wide as at the lower end, golden yellow, without luster; front very deep metallic-green dusted with brown, dull. Antennae bright yellow, third joint slightly infuscated with brown; first joint nearly three times as long as the second and third, black bristly hairs on upper side, second and third joints quite small. Arista very long, about one and one-half times the height of the head, lamella brownish-black and very large, with a very small white area at the base. Orbital cilia black above, yellowish-white below. Thorax and abdomen bronze-green, in some lights somewhat obscured by a greenish-white pollen dark and more shiny along the apical edges. On each side of thorax, in front of the wings, there are two velvety black spots. Hypopygium large, pubescent, which is denser and yellowish-white at the base, towards the apex with a decided purple luster; lamella very pale yellowish, somewhat triangular, hairs and cilia black. Front coxae pale yellow, infuscated at extreme base, with a silvery dust on front surface; middle and hind coxae brownish black, reddish-yellow at the apex. Middle coxae with a golden pollen on front surface, hind pair lightly dusted with a whitish pollen. Legs mostly yellow, tips of middle and hind tibiae and all the tarsi except the base of the front metatarsus (which is yellow) infuscated with brownish-black. In certain lights the front tarsi and under surface of the middle and hind femora silvery white. Front femora with long curly hairs on the outside; middle and hind femora with large bristly hairs on the underside on the apical half. Wings hyaline. Halteres reddish-yellow, slightly infuscated at base of stem. Tegulae pale yellow with long black fringe.

Female.—Face wider and silvery-white. Front deep metallic-green. Antennae very short, third joint a little larger, mostly brownish-black, yellow along the lower edge. Arista not quite as long as face, no lamella, somewhat of an angle near the base; penultimate joint about four times as long as wide. Legs more reddish, tips of all tibiae and tarsi blackish. Under side of femora, all tibiae and tarsi with silvery dust. Otherwise like the male.

Length, 5 mm.

Type locality.—Moscow, Idaho, June 18, J. M. Aldrich, collector.

Distribution.—Juliaetta, Idaho; Boulder, Colorado; Alum Rock Park, San Jose, California, April 5, 1906; Highland Springs, California, August 9, 1911; Mount Lowe, California, July 4, 1917; originally described from one male and two females. Two cotypes (Cat.

No. 24784, U.S.N.M.) and four specimens deposited in United States National Museum by J. M. Aldrich.

12. TACHYTRECHUS MOECHUS Loew.

Fig. 12.

Tachytrechus moechus LOEW, Neue Beitraege, 1861, vol. 8, p. 40, spec. 1.
Macellocerus moechus LOEW, Mik, Dipterologische Untersuchungen, 1878, p. 5, No. 3.

Male.—Face long and narrow, about twice as wide on the lower part as it is just below the antennae, reaching the lower edge of the eyes, covered with a golden yellow dust, dull, front deep green, nearly dull, in certain lights covered with a brown dust. Antennae mostly deep yellow, first joint thick, about four times longer than the second and third joints together, second joint very rudimentary, third joint somewhat rounded and dark brown on apical half to three-fourths; arista a little longer than the head, black, slightly thickened at base, lamella large, black, nearly as wide as long, slightly emarginate on apical edge, with a very small, white area where it joins the stem. Orbital cilia black on apical third, white below. Thorax and scutellum shiny, deep bronze-green in certain lights dull, covered with a bronze dust. Abdomen metallic bronze green, in certain lights with a silvery dust more prominent on basal portion of segments, a narrow blackish area along the apex of each segment. Hypopygium large, blackish green, the green more noticeable at the apex, lightly covered with a yellow dust which is denser near the middle, lower edge on the sides shiny, reddish-black; lamellae deep yellow, rounded, hair black, short, longer on edges. Legs deep yellow, tips of middle and hind tibiae and front tarsi in certain lights slightly infuscated; middle and hind tarsi deep brown. Sometimes a trace of yellow on the basal half of the middle and hind tarsi. Front coxae yellow, blackish along basal edge; middle and hind coxae blackish gray and yellowish at apex. Wings faintly yellowish-brown; halteres yellow, slightly darker at base of stem; tegulae pale yellow with long black cilia.

Female.—Like the male except the differences noted. Face just below the antennae about three-fourths as wide as at the lower part. Antennae with first joint smaller, more reddish-yellow, less swollen; second joint same color as first, less abortive than in the male; third joint rounded, brownish-black, reddish-yellow only on the inferior side of basis. Arista bare, black, tapering gradually to the tip. Abdomen with a little more green. All coxae grayish-black coated with a silvery dust, apex dull, pale yellow; femora brownish-black with a silvery dust, extreme base of femora, apical fourth of the front femora, front tibiae entirely, and basal half to two-thirds of the hind and middle tibiae reddish-yellow; apical portion of middle and hind tibiae and all tarsi brownish-black.

Length 4.5–5 mm.

Type locality.—Trenton Falls, New York (Osten Sacken).

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts.

Distribution.—Lafayette, Indiana, June 8 to July 6, 1915, J. M. Aldrich; Algonquin, Illinois, no date; a specimen marked "N. H." with no date; four specimens deposited in United States National Museum Collection by J. M. Aldrich; Franconia, New Hampshire, Mrs. A. T. Slosson, collection United States National Museum.

13. TACHYTRECHUS SANUS Osten Sacken.

Fig. 11.

Tachytrechus sanus OSTEN SACKEN, Western Diptera, 1877, p. 316.

Macellocerus sanus OSTEN SACKEN, Mik. Dipterologische Untersuchungen, 1878, p. 5, No. 3.

Male.—Face about as long as eye height, just below antennae about one-third as wide as at lower end, golden yellow, without luster; front rather dull, dark green, slightly darker in center and on the ocellar triangle, ocelli yellowish. Antennae yellow, first joint large, reddish-yellow, beset with black hairs above longer near the tip; second joint quite small, placed on the other side of a projection of the first, yellowish; third subtriangular, small, brownish, yellowish on the inner side only; arista slender, nearly twice as long as height of head, lamella black, fairly large and snow-white at base, straight on upper edge. Orbital cilia black. Thorax metallic-green, with two distinct bluish lines on the dorsum, which is very slightly grayish-pruinose, especially about the shoulders. Scutellum metallic-green. Abdomen metallic green, in certain lights whitish pruinose with the apical edge of each segment brownish-black. Hypopygium greenish, with a large patch of brownish-yellow velvety down near the root, long hairs yellowish, those on the side black, in certain lights there is a purplish hue on the apical half; lamellae of moderate size, with yellowish cilia on the sides and black on the apical edge. Prevailing color of legs yellow; front coxae of same color dusted with golden yellow, their extreme root blackish; front, middle, and hind femora, except the base of the latter, all tibiae except the tip of the hind pair and front tarsi except last joint yellow, basal two thirds of middle metatarsi yellowish; front tibiae and tarsi with a silvery dust; middle and hind tarsi, extreme tip of hind tibiae, base of hind femora and last joint of front tarsi brownish-black; front tibiae a row of large black macrochaetae on the front and outside, those of the latter are broader, between these two rows is a row of short bristly hairs. Middle tibia has one large, black macrochaeta on the inner flexor side, near the apex. Wing hyaline; halteres deep yellow slightly infuscated at the base of the stem; tegulae pale yellow, cilia long, black.

Length 5 mm.

Type locality.—Webber Lake, Sierra County, Sierra Nevada, July 22, two males. Osten Sacken.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts. Sixteen specimens deposited in United States National Museum Collection by J. M. Aldrich.

Distribution.—Craig's Mountain, Idaho, Longmire's Springs, Mount Rainier, Washington, August 2, 1905; Fallen Leaf, California, 6500 feet, July 16, 1917; Emigrants Canyon, Wasatch Mountains, Utah, July 8, 1911, 7000 feet, July 21, 1917; Mono Lake, California, July 22, 1911, Tennessee Pass, Colorado, 10240 feet, July 11, 1919.

Female.—Very much like the male except the arista are short and normal; legs mostly black.

14. TACHYTRECHUS GRANDITARSUS, new species.

Fig. 16.

Male.—Face nearly twice as wide on lower part as immediately below antennae; face stops far short of lower edge of eyes; face and entire front green coated with a dull, yellowish dust. Ocelli yellowish. Orbital cilia black on upper third, lower two thirds white. Antennae short, black, joints of nearly equal length; first joint with a few black hairs at the apex on the upper side; arista black and long. Thorax and scutellum bright green well covered with a white dust. Abdomen bright green, in certain lights well covered with a white dust. Hypopygium large and coated with a white dust, it is quite changeable according to the light, varying from white to purple and dark blue; lamellae very long, brown black, tapering gradually from the base to the apex, much narrower at the apex, width of base about one-sixth of the total length, inner edge of lamella nearly straight; all the hair of the lamella black except that on the outer edge which is white and quite long. Legs lightly dusted with white. Basal two thirds of front femora green, that of middle and hind pairs more bluish, tips of all femora, all tibiae and bases of fore and middle tarsi yellow, hind tarsi all brownish black. Middle tarsi are greatly modified, all the joints are very broad and flattened, second joint about four times as long as broad and appearing slightly twisted, the short bristly hairs are arranged in rows. Wings broad and hyaline. Tegulae pale yellow with a small tuft of short black bristles on upper side, near the middle, stems brownish yellow.

Female.—Very similar except the face and front are slightly wider and the middle tarsi are normal.

Length 5–6 mm.

Some specimens vary in color from the general green color to a decided bronze with a reddish reflection in certain lights.

Type locality.—Jacumba Spring, California, June 28, 1917, J. M. Aldrich, collector.

Distribution.—Garfield, Utah, July 9, 1911; Lake Elsinore, California, August 2, 1911; Tempe, Arizona, June 19 to 21, 1917; Saltair, Utah; Great Salt Lake, July 5, 1919, J. M. Aldrich, collector. Los Cerritos, California, April 7, 1915; San Diego County, Desert Edge, California, April 1915, M. C. Van Duzee, collector. Two specimens labeled "Laguna, Calif." and one specimen labeled "Aliso, C." No date nor collector's name given.

Type, male.—*Allotype*, female and fourteen paratypes. Cat. No. 24134, U.S.N.M.

Allied to *T. vorax* Loew but easily separated from that species by being a brighter green, without the spot in the wing and by having the middle tarsi greatly modified.

15. TACHYTRECHUS ANGUSTIPENNIS Loew.

Tachytrechus angustipennis Loew, Centuries, 1861, pt. 2, p. 83, No. 64.
Tachytrechus angustipennis Loew, Aldrich, Trans. Amer. Ent. Soc., 1896, vol. 23, p. 82.

Male.—Face broad, reaching slightly below lower edge of eyes; pale, dull, yellow dust, just below the antennae; about two-thirds as wide as at lower end. Front dusted with green and brown according to the light. Ocelli deep yellow. Antennae small, black, second joint the smallest. Arista black. Orbital cilia black on apical fourth, white on lower three-fourths. Thorax, dorsum, green, covered with a grayish ocher-yellow dust, which makes the green ground color but little apparent; in the middle are two brown longitudinal lines, which diverge a little behind and are very much shortened; the single bristles are inserted upon brownish-black spots. In certain lights there are several small yellowish-white spots. Scutellum a little more brown than the dorsum of the thorax. Abdomen green, covered with a rather thick whitish dust, giving it a checkered appearance; in certain lights the middle line and posterior edges of the segments appear almost black. Hypopygium black, with whitish dust; lamellae of moderate size, rounded oval, with short black hairs. Coxae black with yellowish-white dust, fore coxae beset with extremely short, delicate, sparse hairs; on inner side at apex are a few stiff, long, black bristles. Femora and tibiae greenish or bluish, with a little silver dust, tarsi more of a blackish. Knees reddish. On the hind side of the hind tibiae are two or three remarkably flattened bristles. Wings long and narrow, the costa distinctly thickened upon the middle of the first section. Halteres deep yellow, darker at the base. Tegulae pale yellow, cilia long and black.

Length 4 mm.

Female.—Very much like the male. The color is more of a bronze color; hind tibiae without the flattened bristles on the hind side.

Type locality.—District of Columbia.

Distribution—District of Columbia; Chisos Mountains, Brewster County, Texas, June 10 to 12, 1908, Mitchell and Cushman, collectors; Mount Lowe, California, July 4, 1917; Austin, Texas, May 11 to 18, 1900; Pasadena, California, August, R. W. Doane; Pacific Grove, California, May 5, 1906; Owen's Lake, California, July 27, 1911; Stanford University, California, April 12, 1906; Jacumba Springs, California, June 28, 1917, J. M. Aldrich; Indian School, Pyramid Lake, Nevada, July, 1911; Mono Lake, California, July 23, 1911; Highland Springs, Lake County, California, August 9, 1911, J. M. Aldrich, collector; San Diego, California, April 6, 1915, M. C. Van Duzee. Brewster County, Texas, Chisos Mountains, June 10 to 12, 1908, Mitchell and Cushman, collectors, United States National Museum Collection.

Type.—In Museum of Comparative Zoology, Cambridge, Massachusetts. Eight specimens deposited in United States National Museum Collection by J. M. Aldrich.

16. TACHYTRECHUS PROTERVUS Melander.

Tachytrechus protervus MELANDER, Can. Ent., 1900, vol. 32, p. 143, figs. 6, 7.
Tachytrechus junctus COQUILLETT, Proc. Ent. Soc. Wash., 1910, vol. 12, p. 125.

Male.—Face heavily coated with a silvery dust, below the antennae about half as wide as at the lower end. Front dull, violet brown. Antennae mostly dull yellow; first joint enlarged at apex; second joint with black bristles just below apex; third joint about as long as the first two, with a brown infuscation along upper half. Arista dark brown, thickened basally and not quite as long as the face. Orbital cilia black above, yellowish below. Thorax piceous green; above the base of the wing is a horizontal velvety black spot, above this the dorsum is cupreous; a large silvery area in front of this black spot; on the posterior corners touching the basal corners of the scutellum is a rounded silvery spot. Scutellum like dorsum of thorax. Abdomen dark green, silvery-dusted along the sides, incisures well marked. In some lights there is a reddish or violaceous tinge. Hypopygium piceous, lamellae subrectangular, dark, hairy, evenly fringed with short black hairs, which are longer dorsally toward base. Pleura black, silvery dusted; coxae concolorous except extreme tip, fore coxae bronze-dusted in front. Legs black except the following: Tips of femora below, basal two thirds of middle and hind tibiae and front metatarsi, rather dark yellowish. Forelegs ornamented as follows: Tibiae thickened, dusted with yellow on anterior surface, and with longitudinal rows of short black bristles; tarsi compressed, first joint a little shorter than the rest together,

pulvilli large; third joint in middle tarsus bent. Wings hyaline; posterior crossvein bent slightly inward and with a faint cloud. Halteres yellow. Tegulae yellow, cilia black.

Female.—Differs as follows from the male: Face a little more ochraceous. Infra-alar cilia a little stronger. Vertex, thorax, and abdomen slightly more brassy, brighter green. Red at tip of femora more spread, and at base of middle and posterior tibiae more restricted; fore tibiae yellow, with ordinary bristles; fore tarsi not compressed, first joint equal to next three. Wings with faint yellowish tinge, crossvein more oblique.

Length, male 4.25 mm.; female, 5.5 mm.

Type locality.—Clementon, New Jersey, May 10, 1896, one male and one female from Delaware Water Gap, New Jersey, July 8. Both specimens were received from Mr. C. W. Johnson.

Type.—In the collection of A. L. Melander.

The type of *Tachytrechus junctus* Coquillett is in the United States National Museum Collection as Cat. No. 13091 U.S.N.M.

Other localities.—Hammonton, New Jersey, August 23, 1903, and Lucaston, New Jersey, September 28, 1903, H. S. Harbeck, collector. Lucaston, New Jersey, August 6, 1911, C. T. Greene, collector. Manahawkin, New Jersey, September 5, 1905, H. S. Harbeck, collector. United States National Museum Collection.

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EXPLANATION OF PLATE.

Drawings by C. T. Greene.

Fig. 1. *Tachytrechus vorax*, apex of wing of male.
2. *T. rotundipennis*, apex of wing of male.
3. *T. volitans*, apex of wing of male.
4. *T. floridensis*, apex of wing of male.
5. *T. simulatus*, apex of wing of male.
6. *T. simulatus*, apex of wing of female.
7. *T. olympiae*, front femur of male.

8. *T. auratus*, arista of male.
9. *T. olympiae*, arista of male.
10. *T. tenuiseta*, arista of male.
11. *T. sanus*, arista of male.
12. *T. moechus*, arista of male.
13. *T. bipunctatus*, arista of male.
14. *T. binodatus*, arista of male.
15. *T. laticrus*, arista of male.
16. *T. granditarsus*, middle tarsus of male.
17. *T. laticrus*, front tibia of male.
18. *T. bipunctatus*, hypopygium of male.
19. *T. olympiae*, hypopygium of male.

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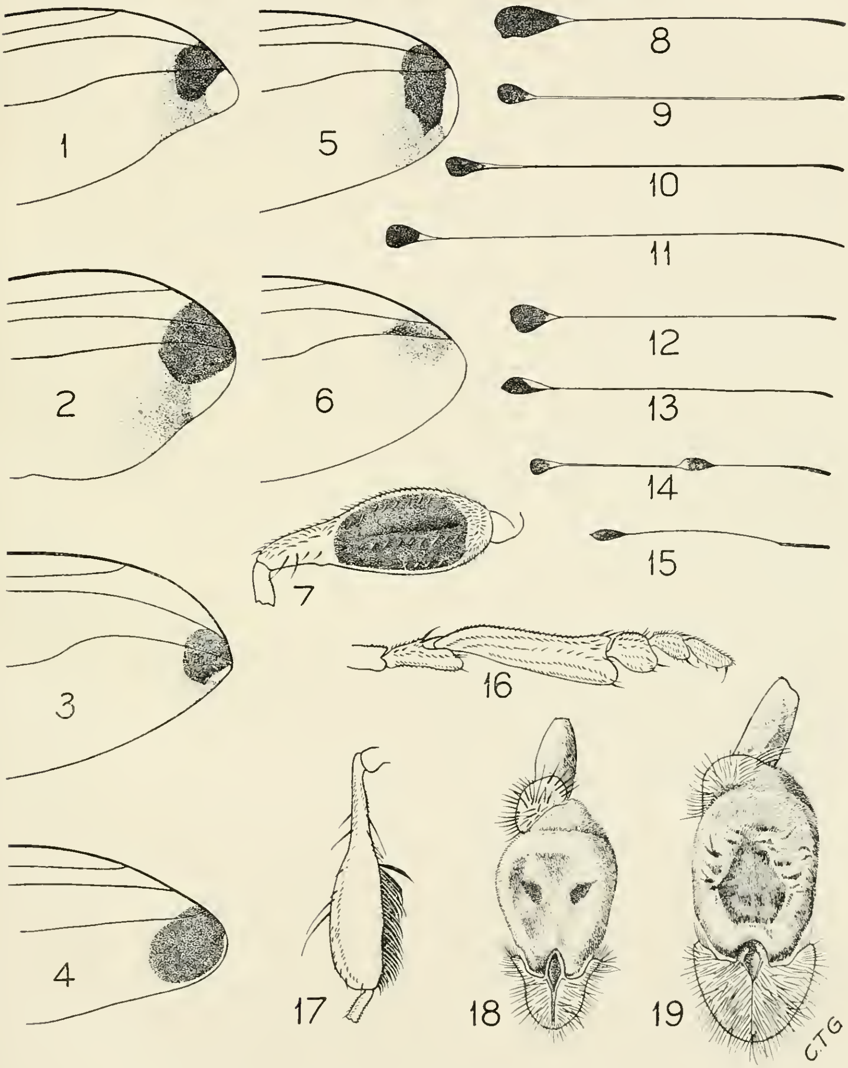

FLIES OF THE GENUS TACHYTRECHUS.

FOR EXPLANATION OF PLATE SEE PAGES 20 AND 21

BEES IN THE COLLECTION OF THE UNITED STATES NATIONAL MUSEUM.—4.[1]

By T. D. A. Cockerell

Of the University of Colorado, Boulder.

In order to facilitate the study of bees, the writer has in preparation a catalogue of the known species, in which will be indicated as far as possible the principal collections in which specimens may be found. When in England during 1920 and 1921, I catalogued the species in the British Museum, the Hope Museum at Oxford, and the Entomological Department of the University of Cambridge. In the United States, I have catalogued the bees of the United States National Museum and the American Museum of Natural History. These various collections contain a very large number of species, and in many cases extensive series of forms not represented in all, if any, of the other museums. Plans are on foot to make exchanges, whereby the museums participating will be able to greatly increase the number of their species.

The British Museum contains the largest collection I have seen, beautifully arranged by the late Mr. Meade-Waldo. Oxford is surprisingly rich, but the W. Saunders collection, S. S. Saunders collection, Rothney collection, and many smaller lots are at present kept separate. The very rich Palaearctic collection of the Rev. F. D. Morice will go to Oxford. Through the kindness of Mr. Morice, I was able to examine his collection, and make many notes. The S. S. Saunders collection was carefully studied by Mr. Edward Saunders shortly before he died, and the species named according to the latest information. Many of the identifications, as they originally stood, were erroneous. At Oxford I found specimens of *Halictus* collected by Darwin on his famous voyage, in Australia and Tasmania. There also may be seen the types of the species collected by Wallace in the Malay Archipelago, including the gigantic *Megachile pluto* Smith. Through the kindness of Professor Poulton I was able not only to make many notes on the materials at Oxford, but a considerable series

[1] For previous papers in this series see Proc. U. S. Nat. Mus., vol. 39, 1911, pp. 635–658; vol. 40, 1911, pp. 241–264, and vol. 55, 1920, pp. 167–221.

will be sent to me for study. Mr. Waterston also promises to send many species from the British Museum, including numerous forms which Mr. Meade-Waldo intended to describe, and had carefully separated for the purpose. The collection at Cambridge is small, though there is a very fine British series from Doctor Perkins. There are about two dozen Cameron [2] types, but the general policy at Cambridge is to give holotypes to the British Museum.

The important Indian collection obtained by Colonel Nurse, containing many types, has gone to the British Museum; but there remained a very large duplicate series, which has been divided between Oxford, the United States National Museum, and the American Museum of Natural History. Comparing the British Museum collection with that of the United States National Museum, I have prepared some statistics, of which the following are samples:

Genus.	Species in B. M. (not U. S. N. M).	Species in both museums.	Species in U. S. N. M. (not B. M.).
Megachile	350	112	119
Stelis (including *Chelynia*)	13	6	21
Crocisa	40	15	5
Nomada	112	43	136
Perdita	2	30	84
Melipona (including *Trigona*)	67	85	85
Osmia	101	46	86
Coelioxys	71	25	44

These figures include only determined species. Races are included. My own collection, which is very rich in species and types, will go to the United States National Museum. After examining various collections I am convinced that for a museum the system of cardboard trays used at Washington is vastly superior to any other and should be adopted as widely as possible.

BOMBUS ABBOTTI, new species.

Female.—Length about 17 mm., anterior wing 14.5 mm. A species of the *B. terrestris* group, with short malar space (broader than long) and entire mandibles. Black, with rather long abundant hair; ocelli small; third antennal joint rather long; clypeus polished, with very sparse punctures; hair of head entirely black; thorax with creamy-white hair, but a very broad black band between the wings; tegulae black; wings dilute brown; legs black, with mainly black hair, but on tarsi it is pale reddish, as also at apex of anterior and middle tibiae, while the long hairs fringing the hind tibiae are mixed

[2] Cameron labeled all the specimens of his new species "type," and distributed them to various museums. Hence one will find "types" of the same species in different collections, no holotypes being designated.

black and red; first two abdominal segments with very pale tawny yellow hair, overlapping the third; third with black hair; fourth to sixth with bright red; venter with much rusty-black hair.

Tagdumbash, Pamir, 13,000 feet, June 11, 1894 (W. L. Abbott).

Type.—Cat. No. 24879, U.S.N.M.

This could be confused with *B. bizonatus Smith*, but the malar space of the female is considerably shorter than in Smith's insect. The paler wings and longer third antennal joint readily separate it from *B. tunicatus Smith.* From *B. niveatus* Kreichbaumer it is known by the much shorter malar space. *B. alticola* Kriechbaumer looks like *abbotti*, but has a considerably longer malar space.

BOMBUS MASTRUCATUS STRAMINEUS Friese, 1909.

Female.—Pognor La, Rupshu, Ladak, 16,000 feet, July 22, 1897 (W. L. Abbott). There is apparently more white hair on the thorax posteriorly than in Friese's type. The mandibles are dentate.

BOMBUS TSCHITSCHERINII Radoszkowsky.

This is a close relative or subspecies of *B. melanurus* Lepeletier, with a broad black band between the wings. Dr. W. L. Abbott obtained it in two localities. (1) Tagdumbash, Pamir, 13,000 feet, June 14, 1894. Two females, of the full size of *melanurus*, but with the light pubescence dull creamy-white instead of yellow. (2) Ooti, Rupshu, Ladak, 15,500 feet, August 4, 1897. One female, hardly 20 mm. long, anterior wing 15.5 mm.; pale pubescence distinctly ocherous. Two distinct races appear to be indicated, but more material is desirable. Other species of *Bombus* reach very high altitudes in the Himalayan region: thus *B. rufofasciatus* Smith, 12,500 feet; *B. flavescens* Smith, over 10,000 feet; *B. miniatus* Bingham, over 10,000 feet; *B. flavothoracicus* Bingham, 12,500 feet; *B. waltoni* Cockerell, 15,000–16,000 feet.

BOMBUS ROBUSTUS HORTULANS Friese.

Female.—Banos, Ecuador (F. Campos). The type locality for *hortulans*.

BOMBUS ATRIPES Smith.

"S. W. pt. Hanan Prov., China" (L. R. Thompson). Four females. The province is marked "Honan" on my map. A magnificent species, colored in the manner of *Bombus morawitzi* Radoszkowski, but the wings are dark fuliginous (pale in *morawitzi*) and the malar space is much shorter. Smith described this and six other *Bombus* from Chusan, but they probably came from more than one locality, as he says: "Mr. Fortune informed me that all the *Bombi* were found on the top of hills in Chusan and adjoining mainland."

BOMBUS RUFOCOGNITUS, new species.

Female.—A species of the *B. mastrucatus* group, with short malar space (though not quite so short as in *mastrucatus*) and toothed mandibles. Length about 22 mm., anterior wing 18 mm.; head with black hair; ocelli small; clypeus convex, polished, dull at sides, very sparsely punctured; malar space broader than long, but not so short as in *B. laticeps* Friese; mandibles 5-dentate; thorax with bright fox-red hair, except a broad black band between the wings; tegulae piceous, reddish posteriorly; wings dark fuliginous; legs black (the hind tibiae and basitarsi obscurely reddish), with black hair, more or less red on femora beneath; first two abdominal segments with bright lemon-yellow hair, next two with black (but the yellow hair overlapping base of third), apex with bright red hair.

Suifu, Szechwan, China (Graham). Two females.

Type.—Cat. No. 24880, U.S.N.M.

The red hair of thorax, contrasting with the yellow of the base of the abdomen, is very remarkable. The species resembles *B. laticeps* Friese, but differs by the longer malar space, and two abdominal segments black-haired. It is easily distinguished from *B. alienus* Smith, by the dark wings. It is readily known from *B. braccatus* Friese by the red thoracic hair and shorter malar space.

Thirty-four forms of *Bombus* are known from China, not including three species and four varieties peculiar to Formosa. None of these is exactly identical with any of the 16 known from Japan or the 3 known from Sakhalin, but a few of the Chinese species occur in the Himalayas. Certain of the Chinese forms have been referred as subspecies or varieties to the European *B. lapidarius*, *hortorum*, *pratorum*, *mendax*, and *terrestris*, but they are at least distinctively colored. Japan contains endemic races of *B. hortorum*, *muscorum*, *silvarum*, *terrestris*, and *pratorum*, in addition to several peculiar species.

BOMBUS TETRACHROMUS Cockerell, 1909.

Bombus nursei, var. *tetrachromus* Friese,[3] is evidently the same thing. The name *tetrachromus* would be the prior one for the species, but as Friese suggests, the *tetrachromus* form is perhaps specifically distinct from *nursei*.

BOMBUS BIZONATUS Smith, 1878.

Kuen Luen Mountains, near Kukiar, East Turkestan, 9,000 feet. July 30, 1894 (W. L. Abbott). One worker. I can not distinguish this in the worker from *B. silantoewi* Morawitz, from Pjatigorsk, N. Caucasus (Skoinikov), but in the female *bizonatus* has longer

[3] Deutsch Ent. Zeit., 1918, p. 85.

wings, and seems to be separable. *B. bizonatus* has conspicuously paler wings than *B. tunicatus* Smith.

Another worker, collected at the same time and place, has the pale hair of thorax and abdomen creamy-white. It looks like *B. abbotti*, but the light hair of basal segments of abdomen is creamy-white instead of yellow, and the hair fringing the hind tibiae is all black. It is a pale form of *bizonatus*.

XYLOCOPA CHIONOTHORAX Cockerell, 1907.

Canton, China, May 18, 1918 (C. W. Howard). Three females. The upper basal edge of the first abdominal segment is rounded, not sharply truncate. The type was described from "China," without other details.

XYLOCOPA ORICHALCEA Lepeletier.

Suifu, Szechwan, China (Graham.)

XYLOCOPA MICANS Lepeletier.

Homestead, Florida, 12 1. 17. (C. A. Mosier.) Two females, one male.

XYLOCOPA TABANIFORMIS Smith.

Panamint Valley, California, April, 1891, (Koeble). Two males.

CENTRIS FLAVIFRONS Fabricius.

Four from Mazatlan and Rosario, Sinaloa, Mexico, presented by B. P. Clark. These are genuine *flavifrons*, not the variety *flavofasciata* which Friese records from Mexico.

CENTRIS DISCLUSA, new species.

Male.—*Like C. nigrofasciata* Friese, with very broad black thoracic band, but hair on hind tibiae and basitarsi long and black (largely tipped with white on basitarsi); tegument of abdomen entirely yellowish-green; second abdominal segment with a large chrome-yellow patch on each side.

Posoya, Ecuador (F. Campos R.). Two males.

Type.—Cat. No. 24881, U.S.N.M.

Unfortunately Friese describes only the females of his *C. nigrofasciata* and *C. buchwaldi*, to which *C. disclusa* is closely allied. Both come from Guayaquil, whence I have a specimen of *nigrofasciata*. *C. disclusa*, by the wholly green abdomen and dark hair on hind legs, should be nearest to *buchwaldi*, but the third abdominal segment has only very scanty short red hairs at apex, instead of being mainly red haired, and the yellow patches on second segment are lacking in *buchwaldi*. It therefore seems that a distinct race or species is indicated, but it is possible that we have the male of *buchwaldi*.

The clypeus (except a black band on each side, not reaching lateral corners), labrum and greater part of mandibles are cream color; there is a narrow transverse supracylpeal band; lateral face marks consisting of bands along the orbits, ending very acutely about level of antennae; scape cream color in front.

CENTRIS POECILA SEGREGATA Crawford.

Female.—Cayuga, Guatemala, June, 1915 (Wm. Schaus). The wings are dilute fuliginous.

CENTRIS TRIGONOIDES Lepeletier.

San Salvador (S. Calderon). Five males. This agrees with Lepeletier's description, noteworthy points being the dark legs (with tarsi chestnut red), the greatly swollen hind femora, and the white face markings. In the long spines on the hind trochanters and the color of the antennae it agrees with *C. dentipes* Smith. The hind tibiae have black hair on outer side, and their femora a good deal of black hair beneath. The eyes are rather pale purplish red; in male *tarsata* Smith, from Guatemala, they are green. The eyes are also green (with dark margins) in *C. totonaca* Cresson.

MESONYCHIUM DECORATUM Smith.

Cayuga, Guatemala, May (Schaus and Barnes); Posoya, Ecuador (F. Campos R.).

EUGLOSSA (GLOSSURA) IGNITA Smith.

Males from Cayuga, Guatemala, September, 1915 (Wm. Schaus), and Colombia (Baker collection). The latter is unusual in having the scape dark, with a small yellow spot, and the mesothorax more or less coppery.

EUGLOSSA (GLOSSURA) PILIVENTRIS IMPERIALIS, new subspecies.

Female.—Rich green, but when seen from a direction opposite the light appearing brilliant purple; on the abdomen the broad hind margin of the first segment is especially purple.

Rio Trinidad, Panama, March 16–23, 1912 (August Busck). Four females, quite uniform in their beautiful coloration.

Type.—Cat. No. 24882, U.S.N.M.

EUGLOSSA VARIABILIS Friese.

Male.—Alhajuelo, Canal Zone, Panama, May 28, 1912 (A. Busck). This species is a little larger than *E. cordata*, and more shining, but it is possible that Ducke is correct in regarding it as a form of *cordata*.

EUGLOSSA VARIABILIS MIXTA Friese.

Female.—Rio Trinidad, Panama, March 19, 1912 (A. Busck).

EUGLOSSA CYANURA Cockerell.

Female.—San Remo, Ecuador, 30 meters altitude (F. Campos R.). Looks like *E. variabilis*, but the black spot on scutellum is very much larger, and the labrum is shorter. The specimen has the mesothorax brassy; the abdomen is emerald green in some lights and deep purple-blue in others.[4]

EUGLOSSA CORDATA (Linnaeus).

This species is very variable and it is possible that several races may be distinguished when adequate field studies and collections are made.

Ancon, Canal Zone, Panama (A. H. Jennings); Taboga Island, Panama, June 13, 1911, and February 24, 1912 (Busck); Alhajuelo, Canal Zone, Panama, May 28, 1912 (Busck); Experiment Station, Matico Hernandez, near Panama City (H. Pittier); Paraiso, Canal Zone, Panama, January 17, 1911 (Busck); Cayuga, Guatemala, June, 1915 (Wm. Schaus); Aquinares, Costa Rica, February, 1921 (A. Alfaro); Cayenne (Wm. Schaus); Cumaragua, Venezuela (B. J. Blanco). A male from Taboga Island, carries a pair of orchid pollinia on its back, so apparently the males may assist in pollinating orchids.

ANTHOPHORA ABJUNCTA, new species.

Female.—Very close to *A. acervorum pennata* (Lepeletier), but third antennal joint shorter (about 0.65 mm.; *pennata* about 0.95 mm.) and more robust; hair of thorax above bright fox-red, without and black intermixed; hair on first abdominal segment exactly as in *pennata*, but on others (dorsally) black or dark brown, with thin bands of long pale fulvous hair; hair on outer side of hind tibiae and basitarsi dark reddish grading into black. It is distinguished from *A. retusa* Linnaeus by the red (not green) eyes, and the first recurrent nervure joining the second submarginal cell far beyond the middle. Face without light markings; hair of head black, grayish on lower part of cheeks; venter of thorax with whitish hair, but sides mainly with bright fox-red; tegulae clear ferruginous; wings dusky; small joints of tarsi dull red; spurs red.

Suifu, Szechwan, China (Graham).

Type.—Cat. No. 24883, U.S.N.M.

The clypeus is dull, and wholly without a median keel (such as occurs in *A. agama* Radoszkowski). This is the sixteenth species of *Anthophora* from China.

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[4] *Male.*—I have recently identified three males from Ancon, Panama Canal Zone, as this species. They have the scape largely pale beneath and the sides of the face narrowly white.—S. A. ROHWER.

TRIGONA HEIDERI Friese.

Manaos, Brazil (Miss H. B. Merrill).

TRIGONA LONGIPES Smith.

Manaos, Brazil (Miss H. B. Merrill.)

TRIGONA WILLIANA Friese.

British Guiana, May 21, 1901 (R. J. Crew); Rio Mato, Caura district, Venezuela, October, 1909 (M. A. Carriker). One Rio Mato specimen bears an additional label: "Taken on trunk of a tree in forest on some gum, where there were many dead ones, covered with white mould."

TRIGONA PECTORALIS Dalla Torre.

San Salvador (S. Calderon).

TRIGONA MELLICOLOR Packard.

Lagunita de Area, Venezuela, 2,000 feet (M. A. Carriker). Belongs to subgenus *Oxytrigona* Cockerell.

TRIGONA CUPIRA Smith.

C. Bolivar, Venezuela, on *Convolvulus* (M. A. Carriker).

TRIGONA RUFICRUS CORVINA Cockerell.

Four workers from banana flowers, Punta de Pena, Panama, August 6, 1906 (R. E. B. McKenney).[5]

TRIGONA PALLIDA Latreille.

La Chorrera, Panama, April 12, 1912 (Busck). I found what is presumably Latreille's type in the Museum at Oxford. It is much broken, with no head. Thorax, abdomen, and hind legs light rufotestaceous. No doubt the species which I have known as *pallida*. The specimen is labeled in Latreille's writing.

TRIGONA MEADE-WALDOI Cockerell.

Joazeine, Bahia, Brazil, August 5, 1915 (P. G. Russell).

TRIGONA SEVOCANS, new species.

Worker.—Length about 7 mm., anterior 7 mm.; clear yellowish-fulvous, with the head mainly black, a large rounded black or piceous patch on lower part of mesopleura, mesothorax black with the anterior corners broadly and lateral margins narrowly yellow; broad

[5] In the Oxford Museum I found *T. ruficrus* (*Apis ruficrus* Latreille), labeled in Latreille's writing. I noted: Wings fuliginous, paler apically; hair on head and thorax above black; hind tibiae and tarsi red; sides of face gray-pruinose; cheeks pale gray-pollinose; mesothorax shining; robust species. This is the species generally known under this name.

apical half of hind tibiae and nearly all of their basitarsi black; tegulae pale fulvous; wings dusky (not whitened apically) with dull ferruginous stigma and nervures. Eyes pale ochreous; head broad, the black parts covered with fine pale brown tomentum, appearing whitish in certain lights; scape entirely yellow in front; face entirely pale yellow up to level of antennae, including the triangular supraclypeal area, lateral face-marks sending a slender line up orbital margins, clypeus without markings; labrum and the simple mandibles yellow; thorax quite densely covered with pale fulvous hair; hind tibiae not exceptionally broad for the genus, fringed in front with sparse long red hairs, but behind with largely dark ones; abdomen narrow, parallel-sided, entirely clear red.

Manaos, Brazil (Miss H. B. Merrill).

Type.—Cat. No. 24877, U.S.N.M.

In my manuscript key to *Trigona* this runs to *T. goettei* Friese, but that has the abdomen brownish apically, and appears to be distinct. It is actually very close to *T. dorsalis* Smith, 1854, but is larger, with the wings not reddened, and the sides of the clypeus straighter. The upper edge of the lateral face marks is gently concave.

TRIGONA SUFFRAGATA, new species.

Worker.—Length about 9 mm., anterior wing 9 mm.; clear red, with the wings dilute ferruginous, the apical margin broadly faintly dusky. No black on thorax, abdomen or legs, but head black, with the face cream color to above level of antennae, and a pair of oval testaceous marks on middle of front. Labrum cream color; mandibles with a large inner tooth, the apical margin and tooth dark; malar space distinct; scape cream color in front, flagellum ferruginous beneath; eyes pale purplish-gray; cheeks covered with pale tomentum. Abdomen parallel-sided, compressed.

Five from Colombia (Harry Sargent).

Type.—Cat. No. 24876, U.S.N.M.

Runs in my table to *T. williana* Friese, but is paler, with differently colored head. The hind tibia also is long, and much more slender basally. It is much larger than *T. mellea* Smith, and differs from that also in the shape of the hind tibia.

NANNOTRIGONA, new genus.

Small black species with very coarsely rugose thorax, and the scutellum elongate, produced into two sharp angles or teeth.

Type.—*Nannotrigona testaceicornis*=(*Melipona testaceicornis* Lepeletier; *Trigona punctata* Smith; *T. perilampoides* Cresson).

NANNOTRIGONA TESTACEICORNIS (Lepeletier).

Lepeletier must have had the common species usually known under *punctata*, *mellaria*, or *perilampoides*, but he erroneously describes

the abdomen as "nigro subvillosum." In the United States National Museum are specimens exhibiting a good deal of variation, as follows:

Apical teeth of scutellum little produced, and end of scutellum (not teeth only) fulvous right across; abdomen appearing pale-banded.
Izamal, Mexico (Gaumer).
Light color at end of scutellum confined to the teeth, or almost so.
Outer face of hind basitarsi dark ---------------------------------- Para, Brazil.
Outer face of hind basitarsi longitudinally bicolored, black and fulvous.
Guayaquil, Ecuador (Buchwald);
Costa Rica (Crawford);
Izamal, Yucatan (Gaumer);
Mexico (Baker collection);
El Rancho, Guatemala (C. C. Deam);
Piura, Peru.

These are certainly only one species, I think. The following appears to represent a good local race.

NANNOTRIGONA TESTACEICORNIS TRISTELLA, new subspecies.

Margins of mesothorax, axillae, and scutellum entirely black.

Four from Lagunita de Aroa, Venezuela, 2,000 feet (M. A. Carriker).

Type.—Cat. No. 24878, U.S.N.M.

MELIPONA FAVOSA (Fabricius).

This was described by Fabricius in 1798 and by Latreille in 1802. In the Oxford Museum I found a specimen labeled by Latreille. It is a *Melipona* with strongly orange-tinted wings; thorax with fox-red hair; clypeus light ferruginous, with two broad dark reddish bars, not reaching upper end, the distance between them less than the width of either; a small semicircular supraclypeal mark; flagellum bright ferruginous beneath; face on each side of clypeus obscure testaceous. Another specimen (not labeled by Latreille) has the supraclypeal mark transversely kidney-shaped.

DOERINGIELLA BIZONATA Holmberg.

Two males from La Rioja, Argentina, donated by B. P. Clark, are smaller than usual, but I think can only be referred to this species.

NOMIA STRIGATA RIDLEYI (Cockerell).

Female.—Canton, China (C. W. Howard). New to China. This is the seventh *Nomia* from China, but doubtless many more occur, as no less than 13 have been described as new from Formosa, while 2 of the mainland species (*thoracica* and *punctulata*) also occur there. Japan has only one recorded genuine *Nomia*, the *N. japonica* of Smith being (according to Meade-Waldo) an *Andrena*.

ANDRENA NIPPONICA, new name.

Andrena japonica Alfken, not of Smith. For its characters, in relation to the other Japanese species, see Annals and Magazine of Natural History for February, 1913 (p. 190).

MEGACHILE STRUPIGERA, new species.

Female.—Length 12mm.; black, slender, parallel-sided, very coarsely punctured, ventral scopa with thickened straplike hairs; clypeus densely rugose, without a smooth line; face and front covered with short red hair; cheeks with very large punctures, and a prominent longitudinal keel posteriorly; antennae entirely black; vertex with scanty red hair; mesothorax and scutellum very densely and coarsely punctured, with short inconspicuous dark hairs; prothorax and tubercles, and a small tuft beneath wings, with bright ferruginous hair; pleura and metathorax with thin white hair; base of metathorax with a narrow transverse channel, crossed by small ridges; tegulae deep red, black basally; wings hyaline at base, beyond that dark fuliginous, splendidly purple-iridescent; legs black, with scanty whitish hair; spurs black; abdomen shining black, not metallic, with large punctures; first four segments with transversely elongated lateral white hair-patches; fifth with a very narrow white marginal band, interrupted in middle; ventral scopa white, black on last segment and apex of penultimate.

Canton, China (C. W. Howard).

Type.—Cat. No. 24884, U.S.N.M.

Closely allied to *M. thoracica* Smith, from Java, but easily separated by the red hair of face and front.

MEGACHILE LATICEPS Smith.

Meade-Waldo in 1914 published the opinion that *M. caecina* Cameron, *M. borneana* Cameron, and *M. varidens* Cameron, all from Sarawak, were identical with the Philippine Island *M. laticeps*. On examining the types in the British Museum, I found that this was not the case. *M. laticeps* has white hair bands at sides of abdominal segments 2 to 4, but fulvous on the first. *M. varidens* has bright fulvous on 1 to 3, and no evident band on 4. *M. varidens* has a dull very densely punctured scutellum, but *laticeps* has it more shining, the punctures not so dense. *M. laticeps* has a broader face and vertex.

M. caecina has red hair on face and thorax; scutellum shining anteriorly. It is in bad condition, but is not *varidens*. *M. borneana* is also different; it has much black hair on thorax above, white at sides and posteriorly; face and front with pale fulvous hair; apex of male abdomen (keel of sixth segment) broadly rounded and emarginate.

EXAERETE NITIDA (Perty).

Friese (1912) has considered this a synonym of *E. dentata* (Linnaeus), but a specimen from F. Smith's collection is separable by the coarsely, confluently punctured areas on mesothorax. Another specimen of *E. nitida* as thus interpreted was recently shown to me by Mr. L. O. Jackson. It was obtained at Jurujuba, State of Rio de Janeiro, Brazil. January 6, 1920 (E. G. Holt).

PROSOPIS LIGULA (Strand).

Female.—Canton, China (C. W. Howard). Strand described this as a variety of *P. transversicostata* Strand, from Formosa, but it is probably a distinct species. I have no Formosan material. but the specimen from Canton agrees with the description. Related species occur from Japan to Burma. There are nine species of *Prosopis* (*sens. lat.*) recorded from Japan, seven forms from Formosa, but only three from China. Evidently there is a considerable series of Chinese species not yet known to science.

SPHECODES HOWARDI, new species.

Female.—Lenth 9 mm. or slightly over; black, including antennae and legs, but first three abdominal segments entirely bright chestnut-red, the apical ones black; wings hyaline basally, but otherwise fuliginous, with splendid purple iridescence; head broad, transversely oval; sides of face with abundant pure white hair; clypeus very short, transverse, not hairy, densely and coarsely punctured, without a median groove; mandibles black, faintly reddish subapically, with an inner tooth; front rugose; thorax with very scanty white hair, mainly on prothorax and pleura; mesothorax with dense extremely coarse punctures, but on disk there are some shining areas between the punctures; scutellum coarsely, irregularly, not densely punctured; area of metathorax with a coarsely cancellate sculpture; tegulae black, with a light spot on outer side; second submarginal very narrow, third broad above; abdomen shining, with scanty very weak and minute punctures, apex with short black hair; spurs red.

Canton, China (C. W. Howard).

Type.—Cat. No. 24885, U.S.N.M.

Related to the Indian *S. fumipennis* Smith, but smaller; also allied to *S. formosanus* Cockerell. from Formosa, and *S. turneri* Cockerell, from Assam. *S. japonicus* Cockerell, from Japan, is also of the same group.

SPHECODES GRAHAMI, new species.

Female.—Of the same size as *S. howardi*, and superficially appearing the same, but differing thus: Apical half of mandibles (which are toothed) dark red; clypeus more finely punctured, with

a distinct median depression or groove (compare the Indian *S. apicatus* Smith); punctures of mesothorax smaller and more sparse, with much shining surface showing; area of metathorax longer, more coarsely and irregularly reticulate; wings, while dusky, not nearly so dark, and without the fine purple iridescence; abdomen with much longer, pale hair in apical region; red of under side of abdomen much darker; stigma larger. The abdomen is almost entirely impunctate. The tegulae are without the light spot on outer side.

Suifu, Szechwan, China (Graham).

Type.—Cat. No. 24886, U.S.N.M.

These two species are easily known from the Chinese *S. kershawi* Perkins (from Macao) by the entirely red base of abdomen; but the female of *kershawi* is unknown, and may well have the base of abdomen all red. By the color of the wings, *kershawi* would fall next to *S. grahami.*

SPHECODES IGNITUS, new species.

Male.—Length a little over 8 mm.; robust; head broad, black, with the clypeus and mandibles dark red; antennae black, the flagellar joints strongly nodose; third antennal joint perceptibly longer than second, but not nearly twice as long, fourth as long as second and third combined; face and front with much white hair; clypeus finely rugose and dull; process of labrum broad, entire, dark; vertex with a very large oval dark reddish tubercle, behind middle ocellus; prothorax (except tubercles), mesothorax, scutellum, and mesopleura, all dark red, postscutellum and metathorax black; mesothorax coarsely and confluently punctured, scutellum with strong scattered punctures; metathorax very coarsely sculptured, the area scarcely defined, coarsely irregularly reticulate, with shining pits; tegulae pale brown, translucent, darker posteriorly; wings deep fuliginous, with the base hyaline; legs black, with the anterior tibiae clear red except the outer face, small joints of tarsi reddish; abdomen polished, with very fine sparse punctures, first two segments and base of third dark red, the rest black, a moderate constriction between first and second segments.

Ocala, Florida, October 24, 1919. Collector not given on label.

Type.—Cat. No. 24887, U.S.N.M.

Related to *S. heraclei* Roberston, but very distinct by the red parts of thorax, etc.

AUGOCHLORA FLORALIA Smith.

Female.—Described from the W. W. Saunders collection, in which I found it. Hind spur pectinate; abdominal segments not vibrissate. The British Museum has no specimens.

AUGOCHLORA LACUSTRIS, new species.

Female.—Length about 10.5 mm.; head and thorax emerald green, abdomen peacock green; hind spur pectinate; abdominal segments not evidently vibrissate, the very fine and short hairs along margins not true vibrissae; flagellum obscure reddish beneath; femora and tibiae green, tarsi rufopiceous, not metallic; wings strongly dusky, stigma dull reddish; second submarginal broad, square; first recurrent meeting second transverse cubitus. Very close to *A. sumptuosa* Smith (which I have from S. Florida, collected by Robertson), but larger, with a good deal of black hair on outer side of hind tibiae; area of metathorax longer, rounded instead of truncate behind; middle of scutellum polished, with sparse punctures; nervures fuscous; clypeus polished and sparsely punctured in middle. The broad abdomen has the same peculiar texture as in *sumptuosa.*

Lakeland, Florida, November 8, 1911 (F. 1753).

Type.—Cat. No. 24888, U.S.N.M.

AUGOCHLORA FLORIDICA, new species.

Male.—Length 11–11.3 mm.; brilliant bluish-green, the abdomen shining, with splendid purple tints, especially the apical half, the hind margins of segments not black; antennae entirely black; mandibles dark reddish on outer side; femora and tibiae green, tarsi becoming rufescent; wings dilute fuliginous; stigma ferruginous, nervures fuscous; first recurrent joining third submarginal near base. Face and front hoary with dull whitish hair; mandibles with a green patch at base; clypeus polished, convex, with strong separate punctures; emargination of eyes shallow; angles of prothorax very distinct; mesothorax densely and quite coarsely punctured; scutellum with a pair of impunctate spots, but these are microscopically roughened; area of metathorax well defined, truncate posteriorly, its surface with weak flexuous rugae; tegulae entirely green; punctures of abdomen very distinct, but not dense; venter rufo-piceous, with strong purple luster on second and third segments; margin of third segment with a median point, that of fourth with a strongly produced median angle, on each side of which the margin is concave. Tongue hardly 1 mm. long.

Monticello, Florida, October 4 to 8, 1914, three males (3625, 3623, 3627).

Type.—Cat. No. 24889, U.S.N.M.

The form and coloration suggest the West Indian *A. piscatoria* Cockerell, but the structure of the abdominal venter is quite different. We are also reminded of the Cuban *A. magnifica* Cresson, but that has hyaline wings and brownish tegulae.

AUGOCHLORA ANONYMA, new species.

Female.—Length about 8.3 mm.; splendid rich purple throughout, on the legs as far as the base of the basitarsi; hind spur with five long spines; flagellum very obscurely reddish beneath, more distinctly at apex; tarsi dull reddish; tegulae purple, with a dark red spot on outer side; wings dusky hyaline, stigma and nervures ferruginous; first recurrent reaching basal end of third submarginal. Mandibles obscurely reddened in middle and with a purple spot at base; mesothorax dullish, rugose; area of metathorax without rugae; abdomen broad and shining, sparsely and indistinctly punctured, the segments not vibrissate, surface thinly hairy; venter with last two segments dark reddish, the others steel blue.

No Name Key, Florida, March, 1898, three females (G. N. Collins and C. L. Pollard).

Type.—Cat. No. 24890, U.S.N.M.

Very distinct by the magnificient purple color, combined with the pectinate hind spur. It belongs to the group Sericei, but will not run in Vachal's key, because the hind margins of the abdominal segments are concolorous, metallic, and yet there is a transverse groove behind the ocelli.

AUGOCHLORA MOSIERI, new species.

Female.—A little smaller than *A. anonyma*, but with exactly the same purple color, so that at first I thought it identical, until I noticed that it belonged to the group Oxystoglossi, with the hind spur not pectinate, and the basal area of metathorax presented strong wavy rugae. Antennae black; mandibles strongly bidentate, chestnut-red in middle; eyes very strongly emarginate; mesothorax dullish without strong punctures; anterior angles of prothorax moderate; wings dark fuliginous, stigma black; knees, tibiae at apex, and tarsi chestnut-red; venter of abdomen piceous, not metallic, the apical segment highly polished; tegulae dark rufous with a metallic spot. The hind margins of the abdominal segments are very narrowly black, as in *A. alcyone* Smith from S. Domingo.

Homestead, Florida, December 1, 17 (C. A. Mosier).

Type.—Cat. No. 24891, U.S.N.M.

AUGOCHLORA PALMARUM, new species.

Female.—(Type). Length 8 to 9 mm.; bluish-green, the clypeus and supraclypeal area yellow-green, contrasting with front and sides of face; antennae black; tegulae rufo-piceous; first recurrent meeting second transverse cubitus; legs piceous, anterior femora steel-blue behind, anterior and posterior (but not middle) coxae green; hind spur not pectinate; abdomen shining, hind margins of seg-

ments very narrowly blackened; no vibrissae; venter piceous, faintly greenish on fourth segment. Eyes deeply emarginate; mandibles dark; clypeus strongly rather closely punctured; mesothorax and scutellum dullish, rugose; anterior angles of prothorax obtuse; area of metathorax rather poorly defined, rugose, with fine striae laterally; hair of hind tibiae entirely pale; abdomen without distinct punctures.

Male.—Length about 7.5 mm.; more slender; eyes strongly converging below; mesothorax with disk polished and shining; area of metathorax with very distinct striae; all the femora metallic; ventral segments 3 to 5 strongly blue-green except broad hind margins, their margins simple, but last ventral with a weak longitudinal carina. The wings are fuliginous.

Palm Beach, Florida, 3 females, 1 male, from the C. F. Baker collection.

Type.—Cat. No. 24892, U.S.N.M.

Belongs to the group Oxystoglossi, and is especially distinguished by the dark wings, whereby it is easily known from the Floridian *A. matilda* Robertson, *A. austrina* Robertson and *A. festiva* Smith. The head is much broader than in *A. cyaneoviridis* Ashmead, from St. Vincent.

NOMADA ALBOFASCIATA Smith.

Male.—Oxbow, Saskatchewan, May, 1907 (F. Knab).

NOMADA MODESTA Cresson.

Female.—Form with yellow mark on mesopleura broken into two spots.

Virginia Beach, Virginia, August 11, 1913 (F. Knab).

NOMADA MEXICANA Cresson.

Cresson described the female. A male from Mexico (Baker collection 1785) is referred here with confidence. It differs from the female thus: Clypeus with a large pale yellow triangular patch, occupying most of its surface; posterior orbits entirely black; metathorax without spots, mesopleura with only one spot, a large one on its posterior part; abdominal venter dark, without markings. The apical plate of abdomen is entire, very obtuse, surrounded by dark bristles.

NOMADA (HOLONOMADA) SUFFOSSA, new species.

Male.—Length about 12 mm.; large and robust; black, with chrome-yellow markings and red legs; readily known by the greatly swollen, oval scape of antennae. Head broad, facial quadrangle about square; mandibles massive, simple, the very broad base yellow, the middle red, the apex black; the following are yellow, labrum,

clypeus, two spots in supraclypeal region, entire sides of face (except black areas below antennae) up to antennae and pointed projection beyond along orbits; cheeks entirely black; scape red laterally and on inner face; third antennal joint clear red, contrasting with the thick dark flagellum, but joints 4 and 5 are red beneath; joint 3 much longer than 4; mesothorax black, entirely dull without evident punctures, but under a microscope it is seen to be so closely punctured as to be minutely cancellate; scutellum with two very large yellow spots, postscutellum with an interrupted band; the following are yellow, upper border of prothorax (not reaching tubercles), tubercles, subtriangular mark on mesopleura, nearly all of tegulae, marks on middle and hind coxae, pair of large transverse marks on first abdominal segment, bands (broad at sides, narrow in middle) on segments 2 to 4, and broad nearly even band on fifth segment, as well as four spots on venter; metathorax entirely black, with pale hair; wings strongly reddened, stigma rather small, bright ferruginous, nervures dilute brown; basal nervure meeting transverse median; first recurrent joining second submarginal about middle; anterior femora at base, and the others in large part, black; hind tibiae and basitarsi with some blackish; hind basitarsi thickened; abdomen extremely densely and minutely punctured; apical plate entire.

Mexico (C. F. Baker collection. 2320).

Type.—Cat. No. 24893 U.S.N.M.

Very distinct from the previously described Mexican or Central American species. In my key to the Rocky Mountain species it runs nearest to *N. superba* Cresson, from which it is known by the bare (instead of copiously hairy) mesothorax and pleura, and many other characters.

PERDITA SPHAERALCEAE ALTICOLA Cockerell.

Female.—Pecos, New Mexico, August 17 (Wilmatte P. Cockerell).

PERDITA RUFICAUDA Cockerell.

I described (1916) only the female. A female and two males were collected by Dr. L. O. Howard at La Mesa, San Diego County, California, April 21, 1898. They differ a little from the type in that the head is dark or bluish, not green. The male runs near *P. chamaesarachae* Cockerell in my tables; it has the face marks lemon yellow, and runs out because the dog-ear marks are present, but there is no supraclypeal mark. The abdomen is entirely clear red.

PERDITA ZEBRATA Cresson.

Female.—Helena, Montana, August 9, 1919. Collector unknown. Described from Colorado.

PERDITA SEMICAERULEA Cockerell.

Five females; Sanderson, Texas, May 9, 1912 (J. S. Mitchell). These are identical with the typical insect of New Mexico.

PERDITA MACROSTOMA, new species.

Male.—(Type). Length a little over 6 mm.; robust, with extremely broad head, the eyes diverging below; head and thorax with thin but conspicuous dull white hairs; head dark blue, the front dull, cheeks shining; cheeks unarmed; clypeus extremely broad and low, with lateral extensions to base of the simple mandibles; clypeus (except a pair of dots), labrum, mandibles (except apically), minute supraclypeal line and small dog-ear marks, and lateral face marks, all cream color; lateral marks transversely cuneiform, with the apex (mesad) obtuse, and the lower outer angle acute; scape cream color in front, black behind; flagellum clear ferruginous beneath, dark brown above; mesothorax shining dark bluish green, metathorax blue, pleura blue; no light markings on thorax; tegulae pale testaceous; wings perfectly clear, margin of stigma and nervures dilute sepia; stigma large; marginal cell oblique at end; legs brown-black, with anterior knees, tibiae and basitarsi in front pale reddish-cream; anterior tarsi and middle and hind knees more or less pale; abdomen ferruginous, polished, the apex broadly bilobed; color of abdomen ferruginous, the first segment brown except apically, the second and third with indistinct, suffused, yellowish bands, and all the segments with suggestions of dusky sublateral spots.

Female.—Length about 7 mm., differing at once from the male in that the abdomen is dark brown, with narrowly interrupted cream-colored bands on segments 2 to 5, those on 2 and 3 produced downward (caudad) at base, becoming pistol-shaped, but not united; head not nearly so broad as in male; mandibles rufo-testaceous, dark at apex; labrum and clypeus reddish-brown, the latter with a plow-shaped cream-colored mark at each side; no supraclypeal or dog-ear marks, but transverse lateral marks, concave above; scape black; flagellum pale rufo-testaceous beneath.

Los Angeles County, California, May, four of each sex (Coquillett).

Type.—Cat. No. 24894, U.S.N.M.

In my key [6] the male runs to 7, except for the simple mandibles; it falls nearest to *P. latior* Cockerell, which also has the abdomen differently colored in the sexes, but differs at once by the large stigma. The female runs to *P. verbesinae* Cockerell, but the head and wings are quite different. There is some resemblance to *P. aureovittata* Cockerell, but that differs greatly in the marking of the abdomen.

[6] Proc. Phila. Acad. Nat. Sci., 1896, p. 45.

The female sometimes has a light median spot on the upper part of the clypeus.

PERDITA DINOGNATHA, new species.

Male.—Length about or nearly 5 mm.; very broad; head extremely broad, dull dark olive-green, orbits diverging below; pubescence on head and thorax dull white, thin and rather short, but distinct; mandibles very long and curved, simple, rufo-testaceous, with dark apex; labrum pale; clypeus broad and low, forming an arched band, entirely pale reddish-testaceous; a minute transverse mark beneath each eye, but no other lateral marks; no dog-ear or supraclypeal marks, but a faint pale supraclypeal shade; cheeks simple; antennae black; thorax black, with the metathorax dark blue; mesothorax dull; tegulae testaceous; wings milky hyaline; stigma narrow-lanceolate, pale yellowish-testaceous, nervures very pale; legs black, the tarsi becoming reddish, anterior tibiae pallid in front; abdomen very broad, shining dark reddish-brown, without markings.

San Diego County, California, April (Coquillett).

Type.—Cat. No. 24895, U.S.N.M.

In my key runs to 52, but runs out on account of the lack of lateral face marks. The stigma recalls that of *P. latior*. The abdomen is redder than that of *P. grandiceps* Cockerell.

PERDITA HAPLURA, new species.

Female.—Length about 5 mm., robust, with broad abdomen; pleura with much white hair, but mesothorax nearly bare; head transverse, but not remarkably broad, orbits converging below; color of head dark bluish-green, most evident on front, which is shining but not polished; no face markings, clypeus and supraclypeal region black; mandibles with a conspicuous red subapical spot; scape black, reddish at extreme base; mesothorax dullish, black, anteriorly strongly brassy; pleura, scutellum and postscutellum black, but metathorax steel-blue or slightly greenish-blue; tegulae testaceous; wings milky-hyaline, stigma and nervures reddish-white; stigma lanceolate, marginal cell very oblique at apex; legs black, anterior knees dark reddish; abdomen dullish black, faintly aeneous at bases of segments, hind margins of segments colorless.

Sanderson, Texas, May 9, 1912 (J. S. Mitchell).

Type.—Cat. No. 24896, U.S.N.M.

Evidently related to *P. texana* (Cresson), but separable by the metallic colors on head and thorax. The male probably has a rufous abdomen.

PERDITA LUCIAE Cockerell.

Male.—Tacna, Arizona (H. G. Hubbard). Named after Miss Lucy Howard.

PERDITA INTERSERTA, new species.

Female.—Length about or hardly 6 mm.; head and thorax shining green, the former bluish-green, the latter yellowish-green; head ordinary; mandibles (except reddish apex), labrum, clypeus, large supraclypeal mark (notched above) and lateral marks pale yellow, but no dog-ear marks or yellow on cheeks; lateral marks shaped like a gloved hand with index finger pointed upward; scape yellow, with a dark apical spot behind; eyes green, blackish at lower end; mesothorax polished, with thin hair; neck entirely yellow, with a yellow line to the similarly colored tubercles; tegulae hyaline with a yellow spot; wings perfectly clear; stigma well developed, very pale orange, nervures very pale; legs yellow, with the hind tibiae dark brown, and their tarsi brownish; abdomen light yellow, with four broad dark brown bands, each covering the apex of a segment and the base of the one beyond; venter yellow.

Los Angeles County, California (Coquillett).

Type.—Cat. No. 24897, U.S.N.M.

No date or plant-record, but it will probably be found on one of the native compositae. In my key it runs to *P. rectangulata* Cockerell, differing at once by the shining thorax. It is close to *P. townsendi* Cockerell, but smaller, with dark hind tibiae and other differences. It is even closer to *P. stottleri* Cockerell, differing by the entirely yellow neck, mainly yellow first abdominal segment, etc.

PERDITA EXCLAMANS Cockerell.

Male.—San Diego County, California, April (Coquillett). It differs a little from New Mexico specimens, having the yellow on pleura divided into two areas, and the fourth broad yellow band on abdomen interrupted. Possibly a distinct race is indicated.

PERDITA QUADRANGULARIS Cockerell.

Male.—Sanderson, Texas, May 9, 1912 (J. S. Mitchell). Described from New Mexico.

BROOKSINA, A NEW PENTAMEROID GENUS FROM THE UPPER SILURIAN OF SOUTHEASTERN ALASKA.

By Edwin Kirk,
Of the United States Geological Survey.

The stratigraphy and paleontologic content of the Paleozoic rocks of southeastern Alaska are perhaps less known than those of any other notable Paleozoic section in North America. Fairly extensive collections of fossils are now available from this region. Of considerable importance in southeastern Alaska is a great series of sediments of doubtful stratigraphic position. Within this series are contained some 3,500 feet of limestone, shales of unknown thickness, and more than 1,000 feet of conglomeratic beds considered [1] as of probable glacial origin. Compared with other North American faunas the fossils of this series bear some resemblance to the Upper Monroe of Michigan. The affinities are not close, however, and consist mainly in the common possession of persistent generic types. It should be borne in mind that the greater part of the Alaskan Paleozoic faunas are Asiatic and European in their affinities, and correlations should be sought there rather than elsewhere in North America. The faunas we are now considering appear closely related to the Lower Devonian of the Ural Mountains as described and discussed by Tschernyschew.[2] Until such time as more accurate correlations of these sediments of the Urals shall have been made with the European standard and the Silurian-Devonian boundary itself shall have been more definitely fixed in Europe the age of the Alaskan sediments must remain in doubt.

My personal inclination is toward the assignment of this Alaskan series to the Devonian. However, owing to the Silurian aspect of the faunas as compared with faunas elsewhere in America, and to the fact that certain of the sedimentary units have already appeared in the literature as of Silurian age it has seemed best tentatively to assign the beds to the Upper Silurian. In any event we probably have to deal with a time period unrepresented elsewhere in North

[1] Kirk, Edwin, Paleozoic glaciation in southeastern Alaska, Amer. Journ. Sci., vol. 46, pp. 511–515, Sept., 1918.

[2] Tschernyschew, Th., Die Fauna des Untern Devon am West-Abhange des Urals, Mém. Comité Géol., vol. 3, No. 1.

Beschreibung des Central-Urals und des West abhanges, Mém. Comité Géol., vol. 3, No. 4.

America, at least by normal marine sediments. In this connection it is of interest to note that Ulrich[3] considers the Upper Monroe as possibly Devonian in age, though placing it in the Upper Silurian.

In addition to the organic types known from the Lower Devonian and Upper Silurian of Asia and Europe the faunas of southeastern Alaska contribute several forms of considerable stratigraphic and paleontologic interest. It is purposed in brief papers to describe some of the more striking and characteristic of these fossils mainly that appropriate names be available for discussion of stratigraphic correlations. It is hoped that in the future with more material available a monographic study of the faunas will be made.

Among the novel and interesting types found in the Upper Silurian rocks the pentameroid brachiopods stand out prominently. A large number of species referable to several genera range through several thousand feet of sedimentary rocks. Where found they serve as excellent horizon markers, the species as a rule being well differentiated and having restricted individual ranges. Among these pentameroids is one genus that is represented by a number of species and as known ranges through 3,000 feet or more of calcareous sediments. As the genus is of considerable stratigraphic importance and appears to be new it has seemed desirable to describe the genus, which is here defined under the name *Brooksina*. As the type species of the genus the species has been chosen which has been found most abundantly and which shows all the characteristic and distinctive features upon which the genus has been established.

BROOKSINA, new genus.

The genus in brief may be defined as a Pentameroid of the *Conchidium* type with the relative convexity and size of the valves reversed. It is to be expected that with a considerable number of species represented forms will be found in which the relative proportions and contours of the valves will approach those of *Conchidium*. As a matter of fact, there are one or two undescribed species which are at present referred to *Brooksina* with a question. Even these, however, are far from typical *Conchidium*. Indeed, it seems probable that *Brooksina* was derived not from *Conchidium*, but a distinct and closely related undescribed genus. The characteristics as given below as distinctive of the genus are found consistently in several well defined species represented by several hundred individuals. Variants from the generic diagnosis as given will not at present be considered otherwise than noting that they exist. The variants are represented by a few specimens only which may ultimately with

[3] Ulrich, E. O., Revision of the Paleozoic System, Bull. Geol. Soc. America, vol. 22, 1911, pl. 28.

more material available be found to represent abnormal types or referable to some other genus. The generic diagnosis will be brief, as the more detailed account of the genotype, *Brooksina alaskensis*, new species, will be found approximately applicable to all the species of the genus represented in the collections. Specific differences lie chiefly in general form, character of surface sculpture, and other relatively minor features.

In *Brooksina* the ventral valve in side view ranges from decidedly concave to slightly convex. The beak is sharply everted as a rule and never involute. The beak terminates in a sharp point. A well marked pseudo-area with cross striations is present. The area is sharply marked off from the remainder of the valve. There is usually a median sinus in the ventral valve and lacking this there is a well-marked median concave or flattened area. The delthyrium is broad and triangular in outline. No deltidium has been seen, but in some specimens there is evidence of marginal outgrowths suggesting deltidial plates. The dorsal valve is strongly convex and its apical portion is sharply incurved. The surface of the valves is marked by sharply defined, narrow, rounded plications. These increase in number either by dichotomy, particularly in the earlier stages of growth, or more commonly by intercalation in later stages. There are usually well-marked concentric growth lines. The shell substance is fibrous. In the anterior portion of large specimens the fibers run in various directions, often at right angles to the plications.

The internal structure of *Brooksina* is similar to *Conchidium*. In *Brooksina* the anterior margin of the ventral septum is straight, whereas in *Conchidium* as known it is concave. The walls of the spondylium in *Brooksina* are relatively closer together than in *Conchidium* and converge dorsad instead of diverging, in all but their posterior portions. The same is true of the crural plates. In the posterior part of the valve these plates behave as in *Conchidium*. Anteriorally, however, they tend to converge ventrad and are often found touching along their ventral margins. The ventral septum reaches to the anterior margin of the valve. The septum in some species is sharply plicated, so that its line of contact with the surface of the valve is strongly crenulate. Between the septa of the dorsal valve is a median ridge, such as is found in *Pentamerus* and *Conchidium*.

In the ontogeny of *Brooksina alaskensis*, as noted elsewhere, very young individuals show a subequality of the valves, with a slight preponderance of the ventral valve over the dorsal. This relation changes rapidly, however, and in moderately young specimens the adult characteristics are well developed. As bearing on the genetic affinities of *Brooksina* it is of considerable interest to note that at no

stage in the ontogeny is there a strong resemblance to *Conchidium.* This lack of resemblance is striking when young stages of *Brooksina* and *Conchidium* are compared. *Brooksina* may not, I believe, be considered a derivative of *Conchidium* proper. Associated with *Brooksina* are *Conchidium*-like forms that have the general characteristics of *Brooksina* without the reversal of valve proportions and complementary peculiarities. It may be necessary to assign these forms to *Conchidium* for want of precise definable distinctions warranting their separation from that genus. It is hoped that with more material available and a better general knowledge of the Pentameroids it will be possible approximately to establish genetic lines and place these aberrant types in their proper niche.

Undoubtedly the genus to which *Brooksina* bears the closest superficial resemblance is *Capellinia.* This genus was described in 1894 by Hall and Clarke (1894, p. 248) and is represented by one species *Capellinia mira* Hall and Clarke from the Silurian dolomites of Wisconsin. As pointed out by Hall and Clarke, *Capellinia* is clearly a reversed *Pentamerus.* As noted by them: "This remarkable shell is virtually a *Pentamerus oblongus* in which the relative convexity of the valves is reversed and the reversion carried to a great extreme." In this description they state that the convex pedicle valve "shows a tendency to trilobation or obscure radial plication." This tendency toward radial folding is likewise apparent in *Pentamerus oblongus*, sometimes to a marked degree. The figures of *Capellinia mira* show these plications, or better, undulations to be of the same sort as are characteristic of *Pentamerus*, that is, low, broad folds. They are quite distinct from the sharply defined narrow plications of *Conchidium.*

In general conformation and gross structure *Capellinia* and *Brooksina* are similar. This is to be expected. *Capellinia* is essentially a reversed *Pentamerus*, whereas *Brooksina* is a reversed *Conchidium. Pentamerus* and *Conchidium* have distinctive characteristics that make their separation imperative. Nevertheless in outward form and gross structure the two genera are often very similar. *Capellinia* and *Brooksina* therefore as somewhat aberrant offshoots from separate but closely related genetic lines are undoubtedly deserving of generic separation. The features which characterize *Conchidium* as opposed to *Pentamerus* are equally applicable to *Brooksina* as compared with *Capellinia.*

The name *Brooksina* is given to this remarkable genus in honor of Dr. A. H. Brooks, of the United States Geological Survey.

So far as known *Brooksina* is restricted to the Upper Silurian of southeastern Alaska. The only fossil suggesting *Brooksina* that has come to my notice outside southeastern Alaska is a form figured by

Tschernyschew.[4] This form Tschernyschew refers to *Pentamerus optatus* Barrande, a species to which it certainly does not seem to belong. So far as the figures go, it is quite possible that the species is referable to *Brooksina.* This species is found in the Lower Devonian of the Urals.

BROOKSINA ALASKENSIS, new species.

This species is represented in the collections by two or three hundred specimens in a fair state of preservation. The specimens were found in residual clay resulting from the surface decomposition of impure limestone along a narrow, slightly shattered fault zone. As a rule the shell substance of the valves is poorly preserved. The leaching of the water either removed the calcareous test or loosened it to such an extent that it exfoliated badly. Patches of the test in good preservation are usually found on each specimen, but individuals which preserve the test in its entirety are relatively rare. The specimens are not distorted, however, and form excellent material for study. The internal structure may easily be examined, either in cross section or by splitting the specimens longitudinally. The material available for study furnishes an unusual series of growth stages. The smallest individual found measures but 3.0 mm. in length by 3.5 mm. in breadth. The largest specimen measures 40.0 mm. in length by 45.0 mm. in breadth. Another large specimen of the same approximate width has a length of 36.0 mm.

Brooksina alaskensis in the case of the largest individuals has a suboval outline when viewed either from the dorsal or ventral side. In smaller specimens, and these may be taken as the average, the anterior margin has the outline of an oval segment, but the posterior portion has a subtriangular outline. In side view the ventral valve ranges from decidedly concave to slightly convex in the portion anterior to the beak, the latter condition obtaining in specimens above the average in size. The dorsal valve is highly convex, the outline being a smooth even curve except in the apical portion, which is abruptly incurved. The preponderance of the dorsal valve over the ventral, both in size and convexity, is marked.

The beak of the ventral valve culminates in a sharp point and is sharply reflexed. From the beak and extending to the lateral margins of the valve are lines diverging at somewhat variable angles, but averaging about 120°, that mark a sharply defined offset or shoulder in the valve. Dorsad to these lines is a concave or flattened pseudocardinal area. There is usually a well-defined median sinus extending from the beak to the anterior margin of the ventral valve. Lacking

[4] Tschernyschew, Th., Die Fauna des Untern Devon am West-Abhange des Urals, Mém. Comité Géologique, vol. 3, No. 1, pl. 7, fig. 94, *a*, *b*, *c*.

a sharply incised sinus its place is taken by a well-defined flattened or slightly concave area. As a rule the sinus is most clearly marked near the beak. Toward the anterior margin it widens rapidly and shows as a broad shallow depression.

The cardinal area of the ventral valve is broad and high. The striations on the area parallel the valve margins and meet the margins of the delthyrium at high angles. They do not radiate from the beak as do the plications of the valves. The area apparently can be classed as a cross striated cardinal area of a nontypical sort. The hinge line is not straight but sinuous, therein differing from the characteristic true cardinal areas of typical forms. On this account it might be better to call an area of this sort a pseudo-area rather than a true cardinal area. The delthyrium is broad and apparently lacks a deltidium. There is some evidence of the presence of marginal outgrowths resembling deltidial plates, but the structure is not clear.

The apical portion of the dorsal valve is sharply incurved and partially fills the delthyrium of the ventral valve. The dorsal valve is most highly arched in the posterior portion. In some specimens there is evidence of a slight median flattening, corresponding to the sinus of the ventral valve, but in most specimens this is wanting.

The valves are traversed by numerous fine, sharply marked, rounded plications. As a rule these multiply by dichotomy, but in older individuals, especially near the anterior margin, the number is frequently increased by intercalation. The plications are equally pronounced on both valves. Concentric growth lines are well marked, and between these the plications are crossed by minor lines that break up the individual plication into a series of beadlike nodes. This character is more pronounced in some individuals than others, and is specially well marked in large specimens near the anterior margin. The growth lines are continuous with those in the pseudo-area.

In *Brooksina alaskensis* the median septum of the pedicle valve as a rule reaches quite to the anterior margin of the valve. Its anterior margin is straight. The median septum from its point of inception at the beak gradually grows higher anteriorly, reaching its maximum height at the anterior margin. The spondylium is very broad and deep in the posterior portion. It narrows very rapidly anteriorly and loses its height more gradually in the same direction. In its anterior portion the walls of the spondylium are but slightly separated and in cross section cases have been seen where the dorsal margins of the plates come in contact. The ventral extremity of the spondylium projects but slightly beyond the anterior margin of the ventral septum. As the median septum and spondylium increase in height in opposite directions there is great diversity in the relative

heights of the two along their lengths. Near the beak the septum is low and the spondylium high, while in the anterior portion the relative height is reversed. In the intermediate region the relative height shifts from one extreme to the other. The combined height of the spondylium and septum is three-fourths or more the depth of the combined valves. The median septum is marked by plications parallel to the anterior margin. The plications may remain narrow and inconspicuous or become very pronounced in the anterior portion. Even in the latter case the line of junction of the septum with the ventral valve remains a straight line. The dental plates likewise are finely striated, the striations paralleling the free margin.

The septa of the dorsal valve are low and extend one-half to two-thirds the length of the dorsal valve. They gradually increase in height anteriorly. In relation to one another they diverge slightly from posterior to anterior extremities, but never become widely separated. In the more mature portions of adult individuals the septa appear practically parallel. Internally the septa stand vertical to the surface of the valve or converge slightly inward. The crural plates maintain about the same height throughout their length. In the posterior portion of the valve the crural plates are sharply reflexed so that their margins are apposed to those of the spondylium. Throughout the greater part of their length the ventral margins of the crural plates are approximately in contact with the dorsal margins of the spondylium. It follows, therefore, that anterior to the region in which the crural plates are widely outspread and reflexed they rapidly assume a subparallel attitude and finally become convergent. In cross sections made some distance anterior to the beak the vertical septa are found supporting rapidly converging crural plates that often come practically in contact along their ventral margins. This is quite different from *Conchidium*, in which the crural plates are prevailingly divergent along their ventral margins so far as known. The crural apophyses are very long, measuring nearly 9.0 mm. in a specimen of average size and extending to a point opposite the anterior extremity of the spondylium. The apophyses are seldom well shown, as in splitting the specimens the line of fracture breaks across them, as a rule. This is due to the fact that the apophyses do not lie in the same planes as the septa, but diverge somewhat laterally. In cross section the apophyses often show where the plane of the section cuts below the level of the spondylium.

The smallest specimen of *Brooksina* observed, which is probably referable to this species, measures 3.0 mm. in length by 3.5 mm. in breadth. In this specimen the ventral valve is slightly larger and more convex than the dorsal. The sinus is sharply marked on the ventral valve. The plications are well developed and extend to the

extreme tips of the beaks. In individuals measuring 5.0 mm. in length by 7.0 mm. in breadth the ventral valve is still slightly convex and somewhat deeper than the dorsal valve. In specimens 9.0 mm. in length by 12.5 mm. in breadth the convexity of the dorsal valve and its relatively greater size is well shown. In specimens of this size the general outline of the ventral valve in side view is concave. At this stage the relative proportions of the two valves are much as in adult individuals except that in later stages the dorsal valve becomes relatively deeper. As noted above, the largest individuals of the species seen measure 45.0 mm. in breadth by 36.0 mm. in length and 45.0 mm. in breadth by 40.0 mm. in length. The average adult of the species as found in the collections gives measurements of about 36.0 mm. in breadth by 30.0 mm. in length. Throughout the series the breadth is consistently greater than the length. The relative proportions change somewhat, the tendency being toward a relatively greater widening in the adults.

Brooksina alaskensis was found in great abundance along the banks of a small stream entering Davidson Inlet along the southeast shore of Kosciusko Island, southeastern Alaska. Associated with *Brooksina alaskensis* is an interesting fauna consisting of a large number of species. The same horizon with approximately the same fauna was found on the north shore of Heceta Island, to the south.

The rocks carrying *Brooksina alaskensis* are tentatively referred to the Upper Silurian, as noted above.

The type specimens are in the collections of the United States National Museum, Cat. No. 68762.

EXPLANATION OF PLATE.

Brooksina alaskensis, new species.

Fig. 1. Young specimen (x2) showing preponderance of ventral valve at this stage.

Fig. 2. Ventral view of larger specimen.

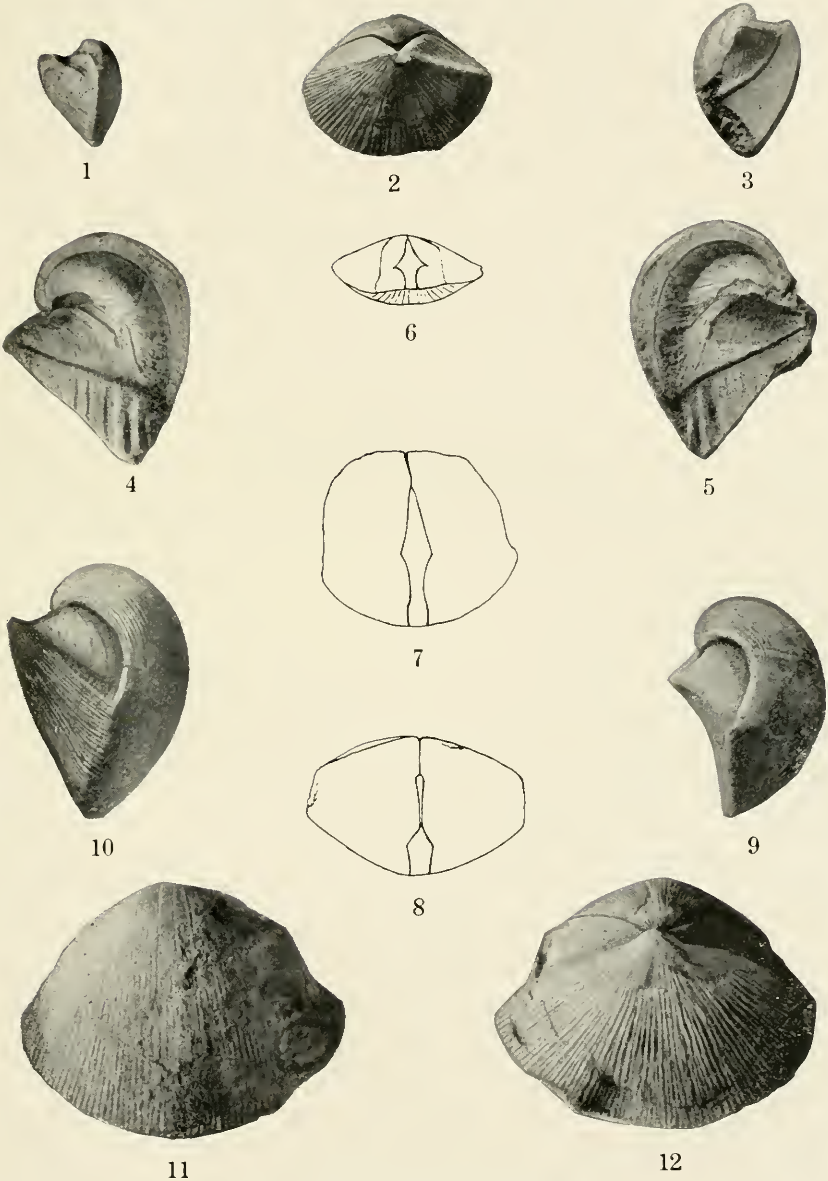
Fig. 3. Young individual (x2) showing internal structure.

Figs. 4, 5. Larger specimen split longitudinally to show septa, spondylium and crural plates. The long crural apophysis and the plication of the ventral septum in the anterior portion are well shown.

Figs. 6, 7, 8. Outlines showing progressive change in relations of septa, crural plates and spondylium. Figure 6 represents a cross section in the posterior portion of a specimen. Figure 7 represents a section about half way between figures 6 and 8, the latter being cut near the anterior margin of the crural plates.

Fig. 9. Lateral view of individual of medium size showing concave profile of ventral valve.

Figs. 10, 11, 12. Lateral, dorsal, and ventral views respectively of a large individual.



BROOKSINA ALASKENSIS, NEW SPECIES.

FOR EXPLANATION OF PLATE SEE PAGE 8.

TWO NEW INTESTINAL TREMATODES FROM THE DOG IN CHINA.

By Marcos A. Tubangui,
Of Los Baños, Philippine Islands.

Among some trematodes in the Helminthological Collections of the United States National Museum collected in China by Dr. R. T. Shields are two forms, one of which represents a species of *Prohemistomum* hitherto undescribed, and the other a variety of *Echinochasmus perfoliatus* differing somewhat from the European specimens of this species as described by various writers. Through the courtesy of the Bureau of Animal Industry, United States Department of Agriculture, I have had the opportunity of making a study of these specimens, and I am indebted to Dr. B. H. Ransom for his friendly interest as well as for the privilege of utilizing the facilities of the laboratory of the Zoological Division in my studies.

ECHINOCHASMUS PERFOLIATUS SHIELDSI, new variety.

Plate 1.

The genus *Echinochasmus* was proposed by Dietz (1909) in order to separate from the old genus *Echinostoma* Rudolphi, 1809, a group of trematodes characterized principally by the presence of a single, dorsally-interrupted row of spines arranged around a kidney-shaped collar, a small cirrus sac which lies anterior to the center of the acetabulum, and vitellaria which extend from the level of the acetabulum to the posterior extremity of the body. In 1911, Odhner raised it to the rank of a subfamily (Echinochasminae), and of its representatives only one, *Echinochasmus perfoliatus*, has thus far been known to infest the dog. It was first recorded by von Ratz (1908), but only a short time afterwards it was again reported by Railliet and Henry (1909) under the name *Echinostoma gregale*. Since then several authors have found it in Europe in the dog, cat, and hog, and, according to Railliet and Henry (1909), the *Distoma echinatum* reported by Generali (1881) might have been the same species.[1]

[1] Dr. W. W. Cort, in a note on January 29, 1921, before the Helminthological Society of Washington, reported an experiment in which Tanabe, as a result of swallowing trematode cysts found in a fish, afterwards recovered from his feces mature flukes that he designated by the name *Echinostomum perfoliatum japonicum*. At the same meeting I called attention to the presence of *Echinochasmus perfoliatus* in China, based upon the specimens described in the present paper. I have also been advised by Dr. R. T. Leiper that he has found *Echinochasmus perfoliatus* to be very common in dogs in Shanghai.

Table of comparison between Echinochasmus perfoliatus von Ratz and Echinochasmus perfoliatus shieldsi.

Designation	*Echinostomum perfoliatum= Echinochasmus perfoliatus.*	*Echinostoma gregale= Echinochasmus perfoliatus.*	*Echinochasmus perfoliatus.*	*Echinochasmus perfoliatus shieldsi.*
Investigator	von Ratz, 1908, from Braun, 1911.	Railliet and Henry, 1919	Ciurea, 1915	Tubangui, 1921.
Length	3-4 mm	2-3 mm	2.11-3.26 mm	1.6-2.05 mm.
Maximum width.	0.6-1.0 mm	0.4-0.7 mm	0.39-0.75 mm	0.39-0.52 mm.
Diameter of collar.	(?)	0.17-0.30 mm	0.22-0.297 mm	0.29-0.34 mm.
Number of collar spines.	12 each side (24).	12 on each side (24).	12 on each side (24).	12 on each side (24).
Arrangement of collar spines.	(?)	1st and 2d behind row.	1st and 2d behind row.	2d in front or 1st and 2d behind row.
Width of ventral space between collar spines.	(?)	0.11-0.125 mm	(?)	0.11-0.12 mm.
Width of dorsal space between collar spines.	(?)	0.057-0.66 mm.	0.063-0.077 mm.	0.08-0.10 mm.
Diameter of oral sucker.	Smaller than acetabulum.	0.085-0.10 mm	0.096-0.136 mm.	0.11-0.13 mm.
Length of prepharynx.	(?)	0.055-0.075 mm.	(?)	0.09-0.13 mm.
Diameter of pharynx.	(?)	0.09-0.095 mm	0.066-0.098 mm.	0.06-0.07 mm.
Length of esophagus.	Long	0.225-0.40 mm	(?)	0.17-0.31 mm.
Diameter of acetabulum.	Larger than oral sucker.	0.175-0.215 mm.	0.167-0.215 mm.	0.21-0.25 mm.
Position of acetabulum.	Between 1st and 2d third.	Anterior third	Anterior third (?) (picture).	Behind anterior third.
Margin and shape of testes.	Big round (smooth?).	Globular, flattened at point of contact.	Ovoidal, smooth or crenated.	Crenated, oval, flattened at point of contact.
Position of testes.	Behind middle of body.	Point of contact behind middle of body.	Nearly in middle of body.	Behind middle of body.
Eggs, length	0.103-0.135 mm.	0.100-0.110 mm.	0.092-0.110	0.097-0.105 mm.
Eggs, width	0.066-0.094 mm.	0.065-0.074 mm.	0.057-0.070 mm.	0.065-0.074 mm.
Habitat	Intestine, dog, cat.	Intestine, dog	Intestine, hog	Small intestine, dog.
Distribution	Hungary	Bucharest	Rumania	China.

The present form, while it closely resembles *Echinochasmus perfoliatus* von Ratz, presents several differential details which, if one could be sure of their constancy, would permit its recognition as a distinct species. But as it is impossible to decide this without examining other lots of specimens from the same locality and, if possible, making an actual comparison with the European form, it has been thought proper to consider this parasite only as a variety of the European species. The accompanying table shows concisely not

only the points of disagreement between the Chinese and European forms, but also the variations that occur in the European form itself according to the descriptions of different writers. These need not be discussed in detail, but on the whole they seem to indicate the existence of varieties in the species. The Chinese variety is shorter and comparatively wider than the European specimens originally described; the prepharynx is longer, the acetabulum larger and placed more posteriorly; the testes are transversely elongated and very noticeably crenated around their margins.

Description.—Length, 1.6 to 2.05 mm.; maximum width, 0.39 to 0.52 mm., measured in the neighborhood of the posterior testis. Lateral margins of the body, from the collar to the acetabulum, rolled ventrally, thus forming a shallow groove on the ventral surface of this region of the body (fig. 1B). Cuticle provided with strong spines which become sparser posteriad and may disappear entirely behind the posterior testis.

Oral sucker, 0.081 to 0.114 mm. long, 0.11 to 0.13 mm. wide, terminal, with the opening toward the ventral surface. Prepharynx 0.09 to 0.13 mm. long; pharynx 0.09 to 0.11 mm. long by 0.06 to 0.07 mm. wide; esophagus 0.17 to 0.31 mm. long, bifurcating in front of the acetabulum into two simple intestinal branches which reach nearly to the posterior extremity of the body. The acetabulum is large, measuring 0.22 to 0.27 mm. long by 0.21 to 0.25 mm. wide, and situated a little more than one-third of the body length from the anterior end. The oral collar, 0.29 to 0.34 mm. wide, is kidney-shaped, its ventral notch measuring 0.11 to 0.12 mm. in width and its dorsal space 0.08 to 0.10 mm. The collar spines number 12 on each side (total 24) and are 0.046 to 0.054 mm. long and 0.011 to 0.015 mm. wide at their bases. The innermost ventral and innermost dorsal of these spines are usually a little shorter than the others. The second ventral spine on one or both sides (numbered from the median line) is often found in front of the row (fig. 1A), but sometimes it is in line with the rest, in which case the first and third may be placed somewhat behind.

The testes possess crenated margins, are oval in shape, elongated transversely, one placed in front of the other with their neighboring surfaces in close contact. The anterior testis measures 0.09 to 0.16 mm. long by 0.19 to 0.24 mm. wide; the posterior 0.13 to 0.18 mm. by 0.16 to 0.23 mm. The two vasa efferentia are given off from their antero-external borders, pass anteriorly on the dorsal side of the acetabulum and empty into a bent, pyriform vesicula seminalis. A thin cirrus sac, which lies anterior to the center of the acetabulum, surrounds the seminal vesicle and short ejaculatory duct. A wide genital sinus, into which the male and female canals open, is located

in the median line between the acetabulum and intestinal bifurcation. The ovary is small, globular in shape, lying toward the right side in front of the anterior testis. The uterus is short and contains only a few eggs. Neither receptaculum seminis nor Laurer's canal were seen. The shell gland is diffuse. The vitellaria extend from the level of the middle of the acetabulum to the posterior extremity of the body. Occasionally they are found as far forward as the level of the genital sinus. In the posterior region of the body behind the second testis the vitellaria from both sides extend across the median line, while in front of the post-testicular region they occur only laterally and mostly on the external sides of the intestinal branches. The transverse vitelline ducts unite in front of the anterior testis, forming a transversely-elongated vitelline reservoir. The oval, thin-shelled eggs are 0.097 to 0.105 mm. long and 0.065 to 0.074 mm. wide, light-yellow in color, and provided with an operculum.

The excretory system follows the general arrangement in Echinostomes. A single stem leads from the terminal excretory pore anteriorly, giving off lateral branches and behind the posterior testis dividing into two main branches, each passing between the testes and the corresponding intestinal branch.

Host.—Dog.

Location.—Small intestine.

Locality collected.—China.

Type specimens.—United States National Museum Helminthological Collections No. 18678, collected by Dr. R. T. Shields.

PROHEMISTOMUM INDUSTRIUM, new species.

Plates 2 and 3.

This parasite represents the second species of the genus *Prohemistomum* Odhner, 1913, to be reported from the dog, the first, *P. appendiculatum*, having been described by Ciurea (1916). The placing of the new species in the genus is based on the general appearance of the body and the arrangement of the internal structures, especially the genital organs. It differs from *P. appendiculatum*, as well as from *P. spinulosum* Odhner, in the presence on its ventral surface, between the folds of the body, of a well-developed clinging plug which resembles that found in the genus *Braunina* Heider, 1900. Like *Braunina cordiformis* Wolfe, 1903, it probably maintains its position inside the intestine of its host by grasping the intestinal mucosa between the folds of the body and the clinging plug.

Description.—Body more or less oval, somewhat pyriform in shape, broad and round anteriorly, narrowing posteriorly. Stout spines cover the entire surface of the body except the clinging plug and the region posterior to the second testis. Length, 1.5 to 1.9 mm.; maximum width, 1.0 to 1.2 mm. and maximum thickness about 0.74 mm.,

both measured at the anterior third of the body. The ventral folds (figs. 2 B and 4 C), which originate on either side of the oral sucker, meet at about the level of the beginning of the posterior third of the body and form the borders of a large cavity occupied by the extensively-developed clinging plug (figs. 2 A, B). The clinging plug ("Haftapparat," "Zapfenapparat") is smooth and dome-shaped externally and provided with a broad base reaching from the acetabulum to a point slightly behind the posterior limit of the ventral folds. In some specimens it is confined within the cavity formed by the folds, but often it bulges out anteriorly in such a manner as to force back and overlie in ventral view both the pharynx and oral sucker (fig. 2 A). In its anterior end, in front of the vitellaria, are found numerous unicellular glands, probably representing the so called "Haftapparatdrüsen."

The oral sucker, 0.10 to 0.13 mm. long and 0. 18 to 0.19 mm. wide, is terminal or antero-dorsal, depending upon the position of the clinging plug. It is immediately followed by a globular pharynx 0.10 to 0.13 mm. long and 0.13 to 0.14 mm. wide. The acetabulum (fig. 4 B), 0.10 to 0.11 mm. in diameter, is weakly developed and hidden by the clinging plug. It is located in the anterior third of the body, a short distance behind the pharynx, at the angle formed by the base of the clinging plug with the anterior region of the body. Its position suggests that it may serve with the ventral folds and clinging plug as an attaching organ. No esophagus being present, the simple intestinal branches arise directly from the pharynx; at first very narrow, they are much wider posteriorly. Their terminations, which are near the posterior end of the body, are visible, but the greater parts of the intestinal branches are hidden between the testes and vitellaria.

The testes are large, smooth, oval in shape, elongated antero-posteriorly and placed one behind the other; their point of contact with each other is about half-way between the anterior and posterior ends of the body. The anterior testis is somewhat smaller and is more inclined ventrally, its anterior extremity extending into the substance of the clinging plug (figs. 4 A, B). It measures 0.49 to 0.52 mm. long and 0.33 to 0.45 mm. wide and, like the posterior testis, it varies in thickness from 0.30 to 0.40 mm. The posterior testis is 0.65 to 0.81 mm. long by 0.36 to 0.38 mm. wide; approximately one-half of its length lies anterior of the posterior limits of the ventral folds and the other half posterior. The vasa efferentia (fig. 4 A) originate from the mid-ventral borders of the testes; the common duct arising from their union, or the vas deferens, enters the cirrus sac and is enlarged to form the vesicula seminalis. The cirrus sac is comparatively very much elongated, lying ventral to the two testes toward the right or left side (amphitypy) and measuring 0.70

to 0.90 mm. long and 0.08 to 0.13 mm. wide at its widest (anterior) portion. It encloses a vesicula seminalis which is not coiled, but is constricted at its middle portion, a pars prostatica and a protrusible cirrus (fig. 3). Cells are present between the wall of the cirrus sac and the vesicula seminalis and pars prostatica. In the unprotruded state the cirrus lies coiled within the sac, and a muscular ring which surrounds its distal portion can be distinctly seen.

The ovary is spherical in shape with a diameter of 0.15 to 0.19 mm. It lies in the substance of the clinging plug, on the ventral side of the posterior surface of the anterior testis, toward the left or right side and opposite the cirrus sac. It gives off from its postero-ventral surface a short oviduct with a distant ootype surrounded by a diffuse shell gland. Laurer's canal is present, but very difficult to find, even in sections, due to its small size and to the fact that it is crowded out by the vitelline glands and reservoir. It opens on the dorsal surface, toward the left or right side, opposite the anterior end of the second testis. The relations of the canal, the oviduct, the unpaired vitelline duct and the shell gland, and the course of the uterus are shown in figure 4 B. The receptaculum seminis is lacking. The vitellaria are very well developed and are composed of large acini measuring 0.13 to 0.15 mm. long and 0.07 to 0.09 mm. wide. They occupy the greater part of the substance of the clinging plug. The transverse vitelline ducts, which could only be made out in sections, are short and the vitelline reservoir is found between the two testes on the same side as Laurer's canal. The terminal portion of the uterus, the vagina, or metraterm, joins the male duct on the ventral side of the latter to form a common passage leading to the genital opening which is situated somewhat dorsally in the posterior end of the body. Surrounding the opening are muscular fibers arranged in circular fashion, but no well-developed genital sinus was seen. The large, thin-shelled eggs are 0.130 to 0.146 mm. long by 0.089 to 0.097 mm. wide. They are oval in shape, light-yellow in color and provided with an operculum.

The excretory system, as in other members of the Holostomata, is in the form of a subcutaneous network of vessels and capillaries. The excretory pore is small, located ventrally with respect to the genital opening.

Host.—Dog.

Location.—Intestine.

Locality collected.—China.

Type specimens.—United States National Museum Helminthological Collections No. 18683, collected by Dr. R. T. Shields.

Besides the type specimens of *Prohemistomum industrium*, the United States National Museum Helminthological Collections (No.

17807) contain a second lot of specimens also collected by Dr. R. T. Shields from the intestine of a dog in Nanking, China, in 1913.

Odhner (1913) considered his genus *Prohemistomum* an intermediate group between the typical Holostomes and the genus *Cyathocotyle* Muehling, 1897, partly because of the incomplete division of the body, externally, into an anterior and a posterior region. With *Cyathocotyle* it has been placed in the subfamily Cyathocotylinae by Railliet (1919), but so far no generic diagnosis has been given.[2] The inclusion of *P. industrium* in *Prohemistomum* brings together species exhibiting two types of clinging plugs as in the genus *Alaria* (=*Hemistomum*). *P. spinulosum* and *P. appendiculatum* have clinging plugs of one type, their clinging plugs being of small size, round to oval in shape and with or without a central depression. *P. industrium* has a clinging plug of another type, its clinging plug being very extensively developed and dome-shaped and occupying at least two-thirds of the body length.

Genus PROHEMISTOMUM Odhner, 1919.

Generic diagnosis.—Alariidae: Small trematodes, not over 2 mm. in length, more or less oval in shape, with the body not distinctly divided into an anterior and a posterior region. The cuticle is provided with spines or with fine scales. The anterior lateral margins of the body are foliaceous and rolled meso-ventrally to form ventral folds which unite posteriorly. Between the ventral folds and behind the acetabulum is a clinging apparatus which takes the appearance of a round or oval, knob-like process, which may or may not present a central depression; or that of an extensively developed plug which reaches anteriorly so as to hide in ventral view the acetabulum, pharynx and even the oral sucker. The simple intestinal branches extend almost to the posterior extremity of the body. The smooth or slightly indented testes lie one behind the other in the posterior half of the body or they may occupy the greater part of the body length between the acetabulum and the posterior end of the body. An elongated cirrus sac enclosing the vesicula seminalis and cirrus lies ventral to the testes. The small, globular ovary is found ventral to the anterior testis, opposite the cirrus sac. The diffuse shell gland, vitelline reservoir and the junction of the ootype and Laurer's canal

[2] Railliet (1919) subdivided the Holostomata into five subfamilies, namely, Strigeinae, Alariinae, Cyathocotylinae, Polyotylinae (Polycotylinae), and Brauninae. The family Strigeidae was proposed to include these subfamilies, so that at present there exist the following terms which refer to the same group of trematodes: Holostomidae, Diplostomidae, Hemistomidae, and Strigeidae. To avoid confusion which is apt to arise by the use of many synonymous names, I would favor the adoption of Hemistomidae against the rest for two reasons: the species represented by *Hemistomum* are better known and they appear to occupy a central position among the Holostomata. It has been pointed out, however, by Krause (1914) and by Hall and Wigdor (1918) that the name *Alaria* has priority over *Hemistomum*, so that the family name Alariidae should be used in place of Hemistomidae.

are located between the two testes. A receptaculum seminis is absent. The vitellaria are in the form of large acini extending from a level posterior to the acetabulum to the second testis or they may occupy the greater part of the substance of the clinging plug. The uterus is short and contains only a few but large eggs, which measure from 0.100 to 0.146 mm. long and 0.06 to 0.097 mm. wide. The vaginal opening is ventral to that of the male in the posterior extremity of the body. A genital sinus may be present or absent, but a bursa copulatrix is lacking. The excretory system is in the form of a subcutaneous network of vessels and capillaries. The excretory pore is ventral with respect to the genital opening.

Parasitic in birds and carnivores.

Type species.—*Prohemistomum spinulosum* Odhner, 1913.

Key to species of Prohemistomum.

1 Clinging plug extensively developed and dome-shaped, occupying at least two-thirds of the body length; acetabulum in anterior third of body, hidden in ventral view by clinging plug; cirrus protrusible ---------- *Prohemistomum industrium*

Clinging plug small, oval in shape; acetabulum midway of body length; cirrus not protrusible ---------- 2

2. Body not over 1.0 mm. in length; oval in shape ---------- *Prohemistomum spinulosum*

Length, 0.90 to 1.75 mm.; posterior extremity of body tapering into a cylindrical appendix ---------- *Prohemistomum appendiculatum.*

Following are brief descriptions of the two previously known species of *Prohemistomum:*

PROHEMISTOMUM SPINULOSUM Odhner, 1913.

Plate 4, fig. 5.

Specific diagnosis.—*Prohemistomum:* The body is broadly oval in form; length, 0.75 to 1.0 mm.; maximum width, 0.45 to 0.65 mm. The anterior two-thirds to four-fifths of the body length is flattened with the margins rolled ventro-posteriorly, producing a spoon-shaped cavity which contains the clinging plug. The posterior body region is not sharply separated from the anterior. The body is thinnest anterior to the clinging plug, but posterior to this level the thickness increases and near the posterior end of the body the proportion of the width to the thickness is 4:3. The cuticle is covered with fine scales except on the clinging plug, the posterior end of the body and the dorsal surface posterior to the anterior testis. The oral sucker, 0.07 to 0.085 mm. in diameter, is small and weakly

developed. The acetabulum is 0.06 mm. long by 0.085 mm. wide and lies in extended specimens midway of the body length. Behind the acetabulum is found the clinging plug which is elliptical in shape, measuring 0.14 to 0.16 mm. long by 0.12 mm. wide and presenting a deep central depression. The pharynx is 0.06 to 0.075 mm. long and 0.045 to 0.055 mm. wide. The esophagus is very short and the intestinal branches extend to near the posterior extremity of the body. The excretory system is in the form of a network. The testes are placed one in front of the other. The posterior testis occupies a median position in the boundary between the anterior and posterior body regions. The anterior testis may be pushed toward the left side of the median line. The margins of both testes are often slightly indented. Ventral to the testes, extending from the level of the anterior testis to the posterior extremity of the body, lies the elongated cirrus sac which encloses the vesicula seminalis, pars prostatica and cirrus. The globular ovary is found ventral to the anterior testis, toward the right side of the median line. The vitellaria are composed of large follicles which hide the posterior portions of the intestinal branches in ventral view. They extend from a level behind the acetabulum to the posterior end of the second testis. A receptaculum seminis is lacking; Laurer's canal is long and the vitelline reservoir lies between the two testes. The uterus is short and contains large eggs (4 to 5 in number) which are 0.10 mm. long by 0.06 mm. wide. The genital sinus is deep and relatively roomy.

Host.—Milvus parasiticus.

Location.—Intestine.

Locality collected.—Cairo, Egypt.

PROHEMISTOMUM APPENDICULATUM Ciurea, 1916.

Plate 4, fig. 6.

Specific diagnosis.—Prohemistomum: Length, 0.90 to 1.75 mm.; width, 0.40 to 0.60 mm., measured at the level of the clinging plug. The anterior region of the body or that region between the oral sucker and the point of meeting of the ventral folds, measures 0.66 to 1.20 mm. long and 0.070 to 0.099 mm. thick in front of the acetabulum. It is not sharply separated from the posterior body region which is 0.33 to 0.53 mm. long and which tapers posteriorly into a cylindrical appendix. The cuticle of the entire anterior body region is provided with fine scales except on the clinging plug. The oral sucker, 0.055 to 0.090 mm. in diameter, is terminal with the opening toward the ventral surface. The acetabulum, 0.050 to 0.085 mm. long by 0.065 to 0.095 mm. wide, lies almost midway of the body length. The simple intestinal branches, from the level of the clinging plug to

their terminations near the posterior extremity of the body, are hidden in ventral view by the vitellaria. Behind the acetabulum is the clinging plug which is 0.150 to 0.245 mm. long and 0.125 to 0.200 mm. wide and which may be provided with a central depression and padded margins. In some specimens the clinging plug is fungiform in appearance and with a smooth surface. The transversely elongated testes lie one behind the other and show slight indentations around their margins. The anterior testis, 0.110 to 0.176 mm. long by 0.154 to 0.240 mm. wide, lies on the median line or slightly toward the left side, ventral to the posterior half of the clinging plug. The posterior testis measures 0.116 to 0.176 mm. long and 0.165 to 0.275 mm. wide. The cirrus sac, 0.154 to 0.176 mm. wide (measured at its middle portion), extends obliquely from the right to the left side of the median line, ventral to the testes. The cirrus opens dorsally into the genital sinus. The small, globular ovary, 0.088 to 0.099 mm. in diameter, lies ventral to the anterior testis toward the left side. The shell gland is found posterior to the ovary and the vitelline reservoir is between the two testes. Between the vitelline reservoir and the left intestinal branch the ootype is situated. Laurer's canal is present. The vitellaria, in the form of large acini, extend from a level posterior to the acetabulum to the second testis. Anteriorly, between the acetabulum and anterior margin of the clinging plug, the vitellaria from both sides of the body unite. The uterus is short and contains only a few eggs (4 to 5 in number) which are 0.100 to 0.117 mm. long and 0.063 to 0.068 mm. wide and are brownish in color The vagina is provided with a muscular sphincter at its opening on the ventral portion of the genital sinus. The excretory system is in the form of a network.

Hosts.—Primary: experimental dogs and cats; secondary: fresh-water fish (*Tinca tinca*, *Aspius aspius*, *Carassius carassius*, *Blicca bjorkna*, etc.).

Location.—Adult in intestine of experimental dogs and cats. Immature form in fresh-water fishes, presumably in the muscles.

Locality collected.—Roumania.

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EXPLANATION OF PLATES.

Index to lettering.

ac	acetabulum.	*os*	oral sucker.
cir	cirrus.	*Ov*	ovary.
col	collar.	*P*	pharynx.
cp	clinging plug.	*Pp*	prepharynx.
cs	cirrus sac.	*sg*	shell gland.
csp	collar spines.	T_1	anterior testis.
E	egg.	T_2	posterior testis.
ep	excretory pore.	*tvd*	transverse vitelline duct.
ev	excretory vessels.	*ut*	uterus.
gen. s	genital sinus.	*vag*	vagina.
go	genital opening.	*vag. sp*	vaginal sphincter.
int	intestine.	*vd*	vas deferens.
Lc	Laurer's canal.	*ve*	vas efferens.
od	oviduct.	*vf*	ventral fold.
Oe	esophagus.	*vit*	vitellaria.
ogs	opening of genital sinus.	*V. r*	vitelline reservoir.
Oo	ootype.	*V. s*	vesicula seminalis.

Plate 1.

Fig. 1.—*Echinochasmus perfoliatus shieldsi*, ventral view; A, same, with collar and spines enlarged; B, same, cross section through pharynx.

Plate 2.

Fig. 2.—A, B, C, *Prohemistomum industrium*, showing general external appearance.

3.—*Prohemistomum industrium*, ventral view.

Plate 3.

Fig. 4.—*Prohemistomum industrium;* A, reconstruction of male genital organs; B, reconstruction of female genital organs; C, cross section through anterior end of posterior testis.

Plate 4.

Fig. 5.—*Prohemistomum spinulosum*, ventral view. Adapted from Odhner, 1913.

6.—*Prohemistomum appendiculatum*, ventral view. Adapted from Ciurea, 1916.

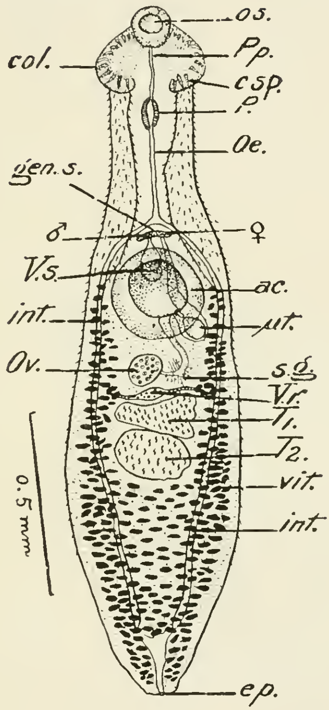

Fig. 1.

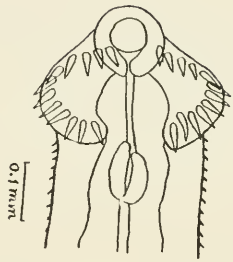

Fig. 1A.

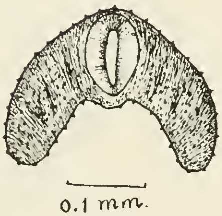

Fig. 1B.

ECHINOCHASMUS FERFOLIATUS SHIELDSI.

FOR EXPLANATION OF PLATE SEE PAGE 12

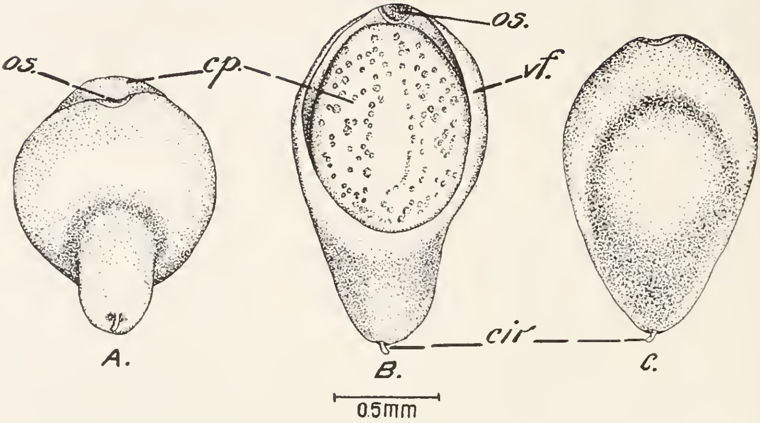

Fig. 2.

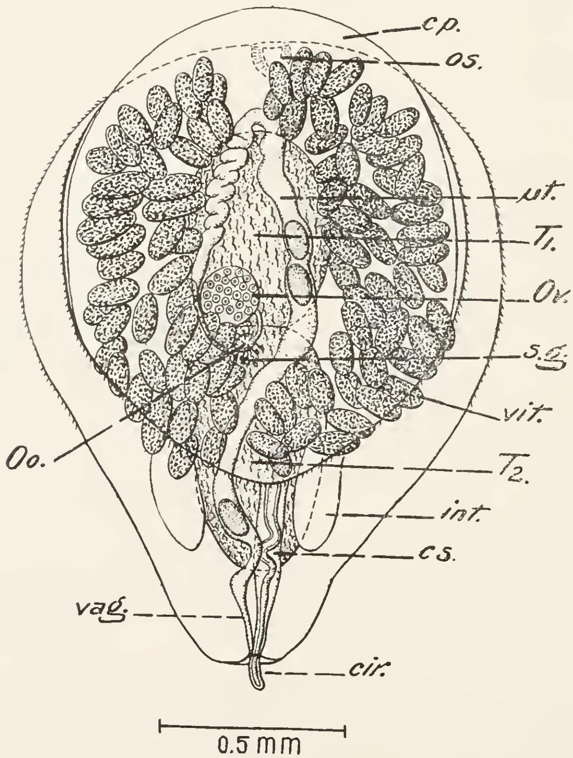

Fig. 3.

PROHEMISTOMUM INDUSTRIUM.

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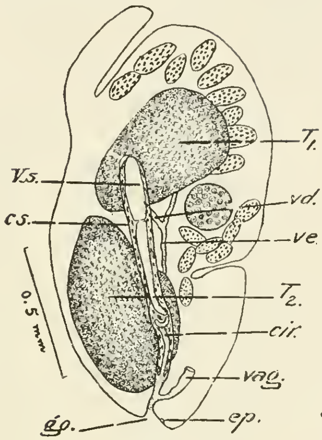

Fig. 4A.

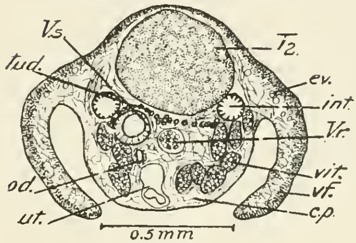

Fig. 4C.

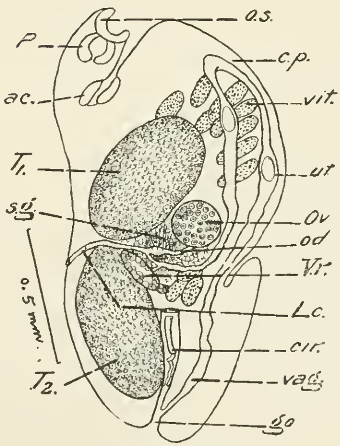

Fig. 4B

PROHEMISTOMUM INDUSTRIUM.

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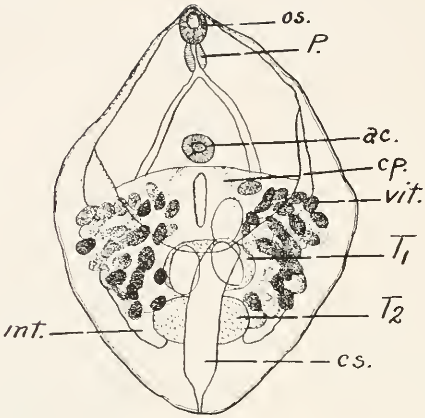

Fig. 5.

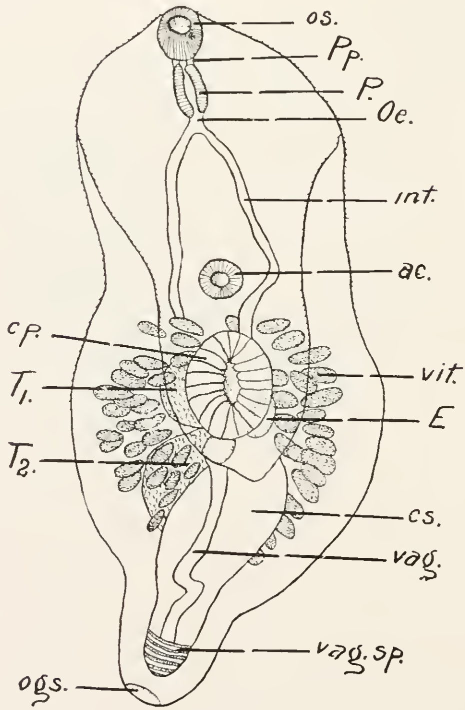

Fig. 6.

PROHEMISTOMUM SPINULOSUM AND PROHEMISTOMUM APPENDICULATUM.

FOR EXPLANATION OF PLATE SEE PAGE 12

NEW SPECIES OF ICHNEUMON-FLIES WITH TAXONOMIC NOTES.

By R. A. Cushman,

Of the Bureau of Entomology, United States Department of Agriculture.

This paper consists of the description of one new tribe, two new genera, and 11 new species of Ichneumonidae, and 5 new species of Braconidae, together with notes on synonymy and generic transfers. The types of all new species are in the United States National Museum.

Family ICHNEUMONIDAE.

Subfamily Joppinae.

Genus HYMENOCAMAROTA, new name.

Camarota Kriechbaumer (1898), preoccupied by *Camarota* Meigen (1830).

AMBLYTELES YAKUTATENSIS (Ashmead).

Plectocryptus yakutatensis Ashmead, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 183, pl. 9, fig. 6.

Plectocryptus popofensis Ashmead, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 183.

This is simply an (*Ichneumon*)=*Amblyteles* with long ovipositor. Ashmead separated his two types by the number of antennal joints and the color of the flagellum, both variable. In a series of seven specimens, including both types, the antennae vary from 24 to 27 jointed; the costulae also vary from entirely absent to distinct.

The ovipositor sheath is hairy only at tip, being otherwise polished. It is closely related to *Cratichneumon popofenis* Ashmead and *confusus* Ashmead described in the same paper. The latter is very likely the male of the present species.

PLATYLABUS PULCHER, new species.

Runs in the keys of both Cresson[1] and Bradley[2] to *lineolatus* Provancher. From the description of that species it differs in having an interruption in the orbital mark about opposite the anterior

[1] Trans. Amer. Ent. Soc., vol. 6, 1877, p. 199.

[2] Can. Ent., vol. 35, 1903, pp. 277–280.

ocellus, another just behind the vertex, and a third at the malar space; the pronotum white margined below as well as above; lateral sutures of mesothorax not white; antennae red at base; abdomen not brownish nor especially truncate at apex, and without a white apical spot.

Female.—Length, 10 mm.; antennae, 10 mm.

Head finely punctate, densely so on face; frons polished impunctate on lower half, opaque in upper half; face divided into three nearly equal areas by two well-defined longitudinal grooves; clypeus weakly separated medially, broadly truncate at apex, sparsely punctate; labrum briefly exserted; malar space slightly longer than basal width of mandible; eyes divergent below; temples convex, strongly sloping; diameter of lateral ocellus equal to ocell-ocular line and slightly shorter than postocellar line; thorax densely, finely punctate; pronotum rugulose in middle at sides; notauli briefly impressed; propodeum punctato-rugulose behind, basal transverse carina entirely lacking, the combined areola and basal area nearly square, spiracle long oval, situated near base and very near to lateral carina, about its length from pleural carina; legs, especially anterior femora, stout, opaque coriaceous; areolet oblique trapezoidal; abdomen subpolished, postpetiole and second and third tergites weakly punctato-shagreened; petiole flat dorsally, the dorsal carinae obsolete on postpetiole; ovipositor barely exserted; hypopygium reaching apex of abdomen.

Bright uniform rufous, with the following ivory white markings: Annulus occupying flagellar joints 9–12 and part of 13, palpi, mandibles, sides of clypeus, malar space immediately at base of mandible, orbits (with interruptions noted above), upper and lower margins of pronotum, line below front wing, posterior half of scutellum, and apex of postscutellum; antennae black, reddish at base; wings pale brownish stained; legs nearly uniform dark reddish testaceous, front pair yellow in front.

Type locality.—Whitefish Point, Michigan.

Type.—Cat. No. 24616, U.S.N.M.

One specimen taken July 2, 1913, by A. W. Andrews.

Genus ISCHNOPSIDEA Viereck.

SYNONYM.—*Rhexidermus* ASHMEAD, not FOERSTER.

(RHEXIDERMUS) ISCHNOPSIDEA JAPONICUS (Ashmead).

Very close to, if not synonymous with (*Ischnus*) *Ischnopsidea nigrellus* (Wesmael). It was the first species included in the genus *Rhexidermus* Foerster, but will not run there in Foerster's key since the scutellum is elevated and the propodeum extends perceptibly over the hind coxae. The type is in the United States National Museum.

(PHAEOGENES) HERPESTOMUS HARIOLUS (Cresson).

SYNONYM.—*Dirophanes plesius* VIERECK.

Viereck's type agrees, except in minor color variations, with Cresson's description.

Subfamily CRYPTINAE.

Genus BATHYMETIS Foerster.

In his paper on the Hymenoptera of the Harriman Alaska Expedition[3]. Ashmead described many so-called species that should all be referred to this genus and resolve themselves into three species. The types of all of these are in the National Collection and have been examined.

BATHYMETIS NIGRUM (Ashmead).

Bachia nigra ASHMEAD, Fur Seal and Fur Seal Islands, pt. 4, 1899, p. 339, female.
Stiboscopus mandibularis ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 172, male.
Bathymetis nigricornis ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 177, male and female.
Bathymetis imitator ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 177, male and female.
Bathymetis simulans ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 178, female.
Bathymetis rubrocincta ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 178, male and female.
Bathymetis simillima ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 179, male and female.
Bathymetis confusa ASHMEAD, Proc. Wash. Acad. Sci., vol 4, 1902, p. 180, male and female.
Bathymetis ungae ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 180, male.
Bathymetis quadriceps ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 181, male.
Bathymetis simulator ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 181, male.
Plesiognathus (*sic!*) *rubrocinctus* ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 184, male.

BATHYMETIS SOLITARIUS (Ashmead).

Stiboscopus solitarius ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 172, male.
Algina alaskensis ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 188, male.
Philonygmus alaskensis ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 189, male.
Ilapinastes incertus ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 190, male.

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[3] Proc. Wash. Acad. Sci., vol. 4, 1902.

BATHYMETIS UNICINCTA (Ashmead).

Habromma nigrum ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 188 (not *Bachia nigra* Ashmead, 1899), male.

Isochresta unicincta ASHMEAD, Proc. Wash. Acad. Sci., vol. 4, 1902, p. 190, male.

ALLOCOTA THYRIDOPTERIGIS Riley.

SYNONYM.—*Phobetus albinopennis* DAVIS.

The type of *albinopennis* is the male of *thyridopterigis.*

(HEMITELES) ZAMICROTORIDEA SYRPHICOLA (Ashmead).

SYNONYM.—*Zamicrotoridea orbiformis* VIERECK.

AMYDRAULAX, new genus.

Genotype.—Amydraulax pulchra, new species.

In Foerster's key to the Hemiteloidae this anomalous genus runs directly to *Rhadinocera*, one of that author's atypic genera, to which I would also run the supposed genotype of *Isadelphus*, *Hemiteles inimicus* Gravenhorst, except for its rather short flagellar joints. That *inimicus* belongs to the present genus I do not believe, but the two have much in common—the clypeus is of the same character, being laterally impressed on each side of the middle at apex with the median portion very slightly emarginate so that the clypeus appears to be obscurely bidentate; the eyes are rather short, leaving a long malar space, and with the antennae placed much below the middle of the eyes; the venation is nearly identical except that in the present genus the second intercubitus is broadly bullated, while in *inimicus* the second intercubitus is entirely lacking, and the bulla of the second recurrent is entire; the form of the abdomen is very similar, the first tergite broad with the spiracles just behind the middle, and the apex strongly compressed; the appendages in the present genus are long and, especially the antennae, very slender, but the relative length of the joints is about the same; the sculpture of the mesoscutum and abdomen is the same in both, very finely granulate.

Among the more striking characters by which *Amydraulax* differs from *inimicus* are the more strongly transverse, unswollen head; the obsolete sternauli; the incompletely areolated propodeum; the very slender antennae and tarsi; and longer and more slender ovipositor. In the last character it is exceeded by *Hemiteles nigriventris* Thomson and *Isadelphus extensor* Cushman. It is perhaps significant that the genotype runs to a genus the name of which refers to the slender antennae; and it may really be *Rhadinocera*, but since Viereck[4] has already included an apparently quite different insect in that genus it seems inadvisable to refer the present species to it.

[4] Hym. Connecticut, 1917, p. 340.

In practically lacking the longitudinal carinae on the propodeum *Amydraulax* resembles the Cryptini, but its other characters ally it more closely to the Phygadeuonini-Hemitelini, while the almost absent sternauli are unusual in either tribe.

Female.—Head transverse; temples strongly narrowed; eyes short and broad, divergent below within; malar space long; face about twice as broad as long with a median rounded elevation flanked by longitudinal depressions; clypeus broad, separated by elevation from face, the apex impressed on each side, the median, unimpressed portion faintly emarginate; antennae extremely slender, filiform, nearly as long as body, first joint of flagellum in genotype about 10 times as long as thick, the others decreasing rapidly in length until near the apex they are but little longer than thick; maxillary palpi slender, reaching beyond apex of front coxae; thorax long, subcylindrical; notauli impressed anteriorly; sternauli very faint; scutellum slightly convex, propodeum with the transverse carinae strong but the longitudinal carinate mostly lacking, basal area and areola completely defined, the latter weakly so at sides and pentagonal, the former large and triangular, spiracles small, round; propodeum and metapleurum sharply separated; legs, especially tarsi, slender, basitarsus about as long as other joints combined and fully half as long as tibia, calcaria short; wings immaculate, radius slightly beyond middle of stigma, areolet complete but with second intercubitus largely bullated, discocubitus with a distinct ramulus, second discoidal cell broad at base, second recurrent with bulla broadly interrupted, nervulus postfurcal and inclivious, nervellus inclivious and broken below middle; abdomen hardly longer than head and thorax combined, compressed from base of third tergite, strongly so at apex; petiole and postpetiole not distinctly separated, the sides of the first tergite slightly arcuate, spiracles just behind middle; first tergite longer than second, second and third subequal, others becoming rapidly shorter; ovipositor long, very slender, slightly compressed, apex barely lanceolate, little deeper than middle.

Male.—Unknown.

AMYDRAULAX PULCHRA, new species.

Female.—Length, 8 mm.; antennae, 8 mm.; ovipositor, 6 mm.

Head slightly wider than thorax; with short, rather dense, white pubescence; temples and vertex behind shining, almost without sculpture; frons granulate above, minutely punctate at sides, polished below, with a shallow furrow above and between antennae; face twice as broad as long, densely, minutely punctate, and with an elongate tubercle between antennae; clypeus twice as broad as long, punctate basally, polished and with a few large punctures dically; mandible punctate; cheeks and malar space punctate, the latter subequal to

basal width of mandible; eye two-thirds as broad as long; basal flagellar joint about 10 times as long as thick; second, three-fourths as long as first; third, three-fourths as long as second; scape densely punctate. Thorax subopaque, mesoscutum granular, scutellum and pleura minutely punctate; propodeum subpolished with more or less coriaceous roughening; basal and apical carinae entire and strong, other carinate absent except basal and middle abscissae of median and apical abscissa of lateral, all of which are weaker than the transverse carinae; basal area large and nearly triangular; areola a nearly equilateral pentagon; spiracle small, round; legs slender, hind basitarsus ten or more times as long as thick, inner calcarium about a sixth as long as basitarsus. Abdomen finely granulate basally, polished apically; first tergite slightly more than twice as long as wide at apex, its sides weakly arcuate, lateral carinae strong to apex, dorsal carinae fading out before middle, the space between impressed; second tergite about as long as wide, its sides somewhat divergent, its spiracles at basal third; third tergite nearly as long as second; others rapidly shorter; sixth and seventh membraneous in middle dorsally.

General body color black, prothorax and mesothorax largely rufous, tergites beyond first with apical margins white, venter largely white; legs largely testaceous; mandibles piceous with white spot toward base; palpi white, apical three joints of maxillary fuscous, antennae black; pronotum black medially and in furrow above; notauli and borders of mesoscutum black; scutellum rufous, its lateral areas black; borders of mesopleurum and entire prescutum black, mesopleurum otherwise and sternum rufous; metapleurum black, more or less reddish in middle; propodeum black; wings hyaline, venation brown, costa, radix, tegula, and humeral angle of pronotum white; legs testaceous, front and middle ones almost stramineous, their coxae at apex, trochanters largely, and femora at base and at apex beneath white; apical joint of hind trochanter and its femur at base white, tibia and tarsus (only the basitarsus is present) fuscous; abdomen black, second tergite medially and laterally at apex narrowly white, other tergites with same markings more distinct, the median and lateral marks narrowly connected; epipleura white, the second with a small brown spot; sternites white with a larger or smaller brown spot at upper anterior angle.

Host.—*Callidium sequoiae* Fisher.

Type locality.—Giant Forest, California.

Type.—Cat. No. 24617, U.S.N.M.

Described from one female reared by F. C. Craighead under Hopkins U. S. No. 10651 P, on December 21, 1918.

The cocoon of the type is nearly cylindrical with rounded ends, 11 mm. long by 2.5 mm. thick. It is semitransparent brown. At a short distance from each end is a series of several opaque longitudinal marks each about 1 mm. long. At the mesal end of each of these is a small whitish patch from which the marking extends toward the end of the cocoon apparently as a welt on the inner surface of the cocoon.

(CRYPTUS) CRYPTOHELCOSTIZUS ALAMEDENSIS (Ashmead.)

SYNONYM.—*Cryptohelcostizus rufigaster* CUSHMAN.

Synomymy based on comparisons of types.

Genus CHROMOCRYPTUS Ashmead.

Chromocryptus ASHMEAD, Proc. U. S. Nat. Mus., vol. 23, 1900, p. 41. Type.—*Chromocryptus albopictus* Ashmead manuscript.
Mesostenimorpha VIERECK, Proc. U. S. Nat. Mus., vol. 44, 1913, p. 566. Type.—*Cryptus nebraskensis* Ashmead.
Chromocryptus CUSHMAN, Proc. U. S. Nat. Mus., vol. 58, 1920, p. 254.

CHROMOCRYPTUS NEBRASKENSIS Ashmead.

Cryptus nebraskensis ASHMEAD, Proc. U. S. Nat. Mus., vol. 12, April, 1890, p. 412.
Cryptus bellus CRESSON manuscript, Ins. Life, vol. 3, November, 1890, p. 154.
Chromocryptus albopictus ASHMEAD manuscript, Proc. U. S. Nat. Mus., vol. 23, 1900, p. 41.
Mesostenimorpha nebraskensis VIERECK, Proc. U. S. Nat. Mus., vol. 44, 1913, p. 566.
Chromocryptus albopictus CUSHMAN, Proc. U. S. Nat. Mus., vol. 58, 1920, p. 254.

The types of both Ashmead's and Viereck's names are in the National Collection. That of *nebraskensis* is from Nebraska; that of *albopictus* from Illinois, while specimens labeled *bellus* are from New York and Connecticut, the former being those on which the Insect Life record of the rearing from *Tolype velleda* was based. Specimens reared from the same host at Obelisk, Pennsylvania, have recently been received from A. B. Champlain of the Pennsylvania Department of Agriculture.

Subfamily ICHNEUMONIAE.

LABENA SCHAUSI, new species.

Has the wings colored as in *gloriosa* Cresson, but because of its lack of the lateral carinae on the face and the sparse punctuation of the mesoscutum it runs in Rohwer's key[5] close to *confusa* Rohwer, from which it differs markedly in color and in other characters.

[5] Proc. U. S. Nat. Mus., vol. 57, 1920, p. 407.

Female.—Length, 19 mm.; antennae, 15 mm.; ovipositor, 15 mm. Face at clypeus and frons about equal in width; face transversely strongly striate with a median carina, but without lateral carinae; frons polished, practically impunctate; vertex and temples polished, impunctate; postocellar line scarcely longer than ocell-ocular line; interocellar space divided by a deep groove; postocellar furrow distinct; clypeus flat basally, without a transverse ridge; thorax polished, with sparse, weak punctures on mesoscutum, scutellum, and dorsal portions of pronotum and pleura; prescutum strongly angulated on each side; mesopleurum with longitudinal impression very weak but with a deep, nearly vertical impression in its dorsal posterior angle; basal area nearly as long as wide at base, its sides convergent posteriorly; costulae far before middle of areola; petiolar area very short, deeply impressed and foveolate medially; subpetiolar area (that portion of propodeum lying below insertion of abdomen) polished, with a few striae; legs slender; subdiscoideus scarcely below middle of postnervulus[6]; nervellus broken distinctly above middle and strongly reclivous; abdomen polished; first tergite two and one-half times as long as wide at apex, apex of sternite much before spiracles; ovipositor distinctly longer than abdomen.

Head and thorax yellow; vertex and upper temples more or less ferruginous; ocelli surrounded by narrow brownish areas; scape, pedicel, and first flagellar joint beneath ferruginous, flagellum black, without annulus; sutures of thorax, three longitudinal fascia on mesoscutum, prescutellar fovea, a band surrounding propodeum, narrow apex of propodeum, and small spot on mesopleurum brownish to blackish; legs testaceous, front and middle coxae and trochanters yellow in front; wings hyaline with black venation and a sharply defined, fuscous spot at apex; first tergite yellow with median piceous fascia reaching nearly to apex; second and third tergites yellow at apex and at anterior angles, piceous in middle, the pattern more obscure on third; other tergites ferruginous, more or less darker in basal middle and more or less yellow laterally at apex; ovipositor sheath blackish, not conspicuously paler at base nor darker at apex.

Type locality.—Cayuga, Guatemala.

Other locality.—Quirigua, Guatemala.

Type.—Cat. No. 24618, U.S.N.M.

Described from two females presented by Mr. William Schaus and collected by Messrs. Schaus and Barnes.

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[6] I propose this term for the vein normally giving rise to subdiscoideus. In the horismology of Rohwer and Gahan it comprises the apical two abscissae of discoideus, and corresponds to the "zweite arealnerv" of Konow. I am proposing the new name instead of using areal vein in order to avoid the confusion that would result due to the fact that Konow and others have in addition applied the latter term to both nervulus and nervellus. The position of subdiscoideus in relation to it is frequently of much value in classification and the new term is proposed for the convenience of having a definite and comparatively short name.

The paratype is larger (23 mm.) but differs otherwise only in minor details.

NESOPIMPLA NARANYAE Ashmead.

Nesopimpla naranyae ASHMEAD, Proc. U. S. Nat. Mus., vol. 30, 1906, p. 189, pl. 13, fig. 3.
Itoplectis immigrans TIMBERLAKE, Proc. Hawaiian Ent. Soc., vol. 4, 1920, p. 271.

In searching for Timberlake's recently described species in the National Collection I have discovered that it had been previously described from Japan by Ashmead under the above name, Ashmead's type agreeing perfectly with Timberlake's description. In addition to the type female, there are in the National Collection a male from the same source as the type; another male from the type locality; a female and a male collected by Y. Nawa, the female at Gifu and the male without locality but said to have been reared from the pupa of *Nonagria innocens;* and two males from Hawaii both collected by Ashmead, one at 4,000 feet on Kilauea and the other at 2,500 feet on Olaa Plantation.

The sixth tergite varies from all red to all black, and there is, in the specimens examined, no such difference between the sexes in color of abdomen as described by Timberlake.

Nesopimpla is at least subgenerically distinct from *Itoplectis* in the strong median and lateral carinae of the propodeum, the lack of basal lobes on the front tarsal claws in the female, and the reflexed apex of the seventh tergite in the male.

EPHIALTES SANGUINEIPES (Cresson).

Pimpla sanguineipes CRESSON, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 165.
Pimpla hawaiiensis CAMERON, Proc. Haw. Ent. Soc., vol. 3, 1915, p. 105.
Ephialtes hawaiiensis TIMBERLAKE, Proc. Haw. Ent. Soc., vol. 4, 1920, p. 267.
Ephialtes sanguineipes CUSHMAN, Proc. U. S. Nat. Mus., vol. 58, 1920, p. 335.

I have compared the large series of *Ephialtes hawaiiensis* (Cameron) in the National Collection with the equally large series of *sanguineipes* (Cresson) and am unable to distinguish between them. The larger males of *sanguineipes* have the hind tibiae entirely red like the female, but many smaller specimens, including a few very small females placed in *sanguineipes* by myself, have the tibiae more or less distinctly bicolored. I am not at all sure but that *sanguineipes* (Cresson), *punicipes* (Cresson), *feralis* (Cresson), and *exareolatus* (Ashmead) are variants of the same species. But the last three are all represented in the National Collection by uniques that can be distinguished from the general run of *sanguineipes*.

Genus XANTHOPIMPLA Saussure.

SYNONYM.—*Neopimploides* VIERECK.

XANTHOPIMPLA PUNCTATA (Fabricius).

SYNONYM.—*Neopimploides syleptae* VIERECK.

Viereck's type agrees in every way with what appears to be commonly accepted as the Fabrician species.

(EPIURUS) ZAGLYPTUS CARPOCAPSAE (Ashmead).

This Russian species is a true *Zaglyptus* and runs in Schmiedeknecht's Opuscula Ichneumonologica (p. 1161) to *varipes* (Gravenhorst). Differs in being large red and in having yellow markings on face and scutellums. The host record of the type is undoubtedly erroneous, the species of *Zaglyptus* being parasitic on spider eggs.

ASPHRAGIS? CHINENSIS, new species.

Runs in the keys of Foerster, Ashmead, and Schmiedeknecht to *Asphragis*, but differs from all of the North American and European species referable to that genus that are known to me in the form of the apex of the ovipositor. In the present species this has two notches dorsally a short distance back from the apex, while in the other species there is only one notch.

The species is also rather peculiar in its host relations, the seven specimens having been reared in two lots from some insect that makes a slight gall on twigs of pear by boring in the pith.

Female.—Length, 4 mm.; antennae, 2.75 mm.; ovipositor, 2.5 mm. Head rather full and rounded, distinctly wider than thorax; finely punctate, face and frons densely, temples sparsely so; occiput shallowly concave; frons convex; face with a median rounded elevation, flanked on either side by a shallow impression; malar space equal to basal width of mandible; cheeks convex; clypeus convex, rounded at apex, about twice as long as broad, distinctly discreted; ocelli in a low triangle, postocellar line much longer than ocell-ocular line and nearly three times as long as diameter of lateral ocellus; first joint of flagellum distinctly longer than second, apical joint large. Thorax cylindrical, slightly more than twice as long as high, shining, minutely punctate, densely so on mesoscutum; pronotum polished, largely impunctate; propodeum weakly coriaceous above, polished behind, pleural and apical carinae distinct; legs long, slender; wings large, areolet entirely wanting, nervulus postfurcal, inclivous, basal vein strongly curved, nervellus broken far below middle, inclivous. Abdomen as long as head and thorax together, subpolished-coriaceous, first tergite narrowly sessile, two-thirds as wide at apex as long, with a median subapical impression, dorsal carinae fading out at spiracles, which are distinctly before middle; other tergites transverse; second and third, especially the second, with transverse, subapical impressions, thyridia small but distinct, trans-

verse; ovipositor slender, longer than abdomen, apex subsagittate with two notches dorsally.

Black with abdomen beyond first tergite and legs largely reddish; clypeus, mouth parts, tegulae, humeral spot, subtegular spot, and anterior coxae in front white; a very small spot at top of eye and one on side of mesoscutum brown; antennae black with basal joints brown, especially beneath; hind tibiae at apex and their tarsi slightly infuscate; wings hyaline, venation brown; first tergite at apex reddish, second with a median blackish spot; ovipositor sheath black.

Male.—Differs from female in being more slender and in color as follows: Spot at top of eye together with small spot on lower inner orbit and paired spots on middle of face yellow; coxae black at base, hind pair largely so, otherwise, together with front trochanters, white; abdomen largely black, the red being confined to the lateral margins and sutures.

Host.—Pith-borer in pear twigs.

Type locality.—China.

Type.—Cat. No. 24619, U.S.N.M.

Described from seven specimens in two series. The series from which the type is selected consists of two females and one male reared at quarantine, Washington, District of Columbia, under Federal Horticultural Board No. 29265, from material received from China. Four other females were reared from galls on pear collected by F. N. Meyer in the Pangshan Mountains, North China. These are somewhat larger, more coarsely sculptured, and with the red of abdomen and legs paler than in the others. The hind tibiae and tarsi are entirely red. The brown spot on mesoscutum is larger than in the type. The male and the second female of the first series lack the mesoscutal spots entirely.

Subfamily TRYPHONINAE.

(SYCHNOLETER) ZAGRYPHUS AMERICANUS (Ashmead).

Ashmead's type (Cat. No. 22748, U.S.N.M.) is a male. Both hind tarsi, all but two joints of the left antenna, and all but six joints of the right antenna are missing. It is of about the same length as *nasutus* (Cresson), but more slender with the head smaller. It may be further distinguished from the male *nasutus* as follows:

Head black; clypeus nearly twice as long as face; propodeum strongly mucronate on each side behind; postpetiole as wide at apex as long from spiracles; second tergite as wide at apex as long, its sides divergent. **nasutus.**

Head brown; clypeus only slightly longer than face; propodeum weakly mucronate; postpetiole narrower at apex than long from spiracles; second tergite narrower than long and parallel-sided------------------**americanus.**

This species was referred by Davis in the index to his review of the Tryphoninae[7] to the Cryptinae without indicating the genus to which he would refer it.

NELIOPISTHUS NIGER, new species.

Female.—Length, 5 mm.

In my key to females of North American species[8] runs to *nigridorsum* Cushman, agreeing with all of the characters except that the ovipositor is but little longer than the first tergite. It differs further from *nigridorsum* in having the thorax entirely without red laterally. Its much broader abdomen as well as its black thorax at once distinguish it from *densatus* (Say) (=*similis* Cushman). From *luggeri* (Ashmead), to which it is very closely allied structurally, it differs in addition to the color in having the nervellus broken higher (at about the lower third) and in having the postpetiole medially with a deep impression. The male of *luggeri*, which is black, can be distinguished from *niger* by the structural characters.

In structure much as in *luggeri*, with exceptions noted above and with areola distinctly transversely rugose.

Black with the usual pattern of white somewhat less extensive on the face; narrow apical margins of tergites and scutellum reddish; annulus of antenna incomplete and occupying only two joints; legs darker throughout with middle coxa at base, hind coxa entirely, and their trochanters partly piceous to black; hind femur at base, tibia dorsally, and tarsus infuscate.

Type locality.—Florissant, Colorado.

Type.—Cat. No. 24620, U.S.N.M.

One female taken June 21, 1908, by S. A. Rohwer.

BOETHUS NIGRIPENNIS, new species.

Very distinct from all other North American species in size and color.

Female.—Length, 8.0 mm.; antennae, 7.0 mm.

Entire body and legs smooth and polished, clothed with short silky pubescence especially dense on face propodeum and first tergite, which are almost velvety.

Head in front view wider than long; face broader than height of eye; malar space more than half as long as basal width of mandible; clypeus about half as long as interfoveal line; eyes parallel within; antennae rather stout, the flagellum with about 30 joints; mesopleurum entirely without trace of punctiform fovea near posterior margin; radial cell measured on metacarpus barely as

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[7] Trans. Amer. Ent. Soc., vol. 24, 1897, p. 346.
[8] Proc. U. S. Nat. Mus., vol. 56, 1919, p. 379.

long as stigma, radius curving sharply forward at apex; intercubitus much shorter than second abscissa of cubitus; second recurrent nearly straight; nervulus postfurcal; nervellus broken at lower two-fifths, inclivous; first tergite about half as wide at apex as long, the spiracles subprominent; gastrocoeli transverse, removed from base of tergite by about their breadth; tergites not membranous in apical middle.

Head and thorax black above, yellowish piceous below; the latter color embracing the face, cheeks, lower part of propleura and pronotum, mesosternum, mesopleurum along posterior suture, and more or less of metapleurum and side of propodeum; clypeus and mandibles yellow; coxae piceous; paler toward apex; trochanters and bases of femora yellowish testaceous as are also the underside of front and middle tibiae, front tarsi and calcaria; legs otherwise black; wings deep black; abdomen rufous, the sternites and edges of apical tergites darker.

Male.—Differs in having head except clypeus and mouth parts, thorax and legs except apices of trochanters and calcaria entirely black.

Host.—Arge salicis.

Type locality.—Ammons, Breckinridge County, Kentucky.

Type.—Cat. No. 24626, U.S.N.M.

Described from three females and six males reared by Prof. H. Garman from cocoons of host collected in drift along Ohio River.

The smallest specimen, a female, is 6 mm. long with antennae practically as long as body. Paratype *a*, female, has the sternites and edges of the tergites almost black.

The type, allotype, and four paratypes are in the National Museum and three paratypes returned to Professor Garman.

The following key will separate the North American species of *Boethus:*

KEY TO NORTH AMERICAN SPECIES OF BOETHUS.

1. Gastrocoeli of second tergite longitudinal; mesopleurum with a punctiform fovea near posterior margin; intercubitus nearly or quite as long as second abscissa of cubitus; nervellus broken at lower fourth ________ 2.
   Gastrocoeli transverse; mesopleurum without fovea; intercubitus much shorter than second abscissa of cubitus; nervellus broken at or above lower third; first tergite not or barely half as wide at apex as long ________ 3.
2. Thorax below and abdomen largely black ________ aenigmaticus Viereck.
   Thorax and abdomen entirely red; first tergite fully two-thirds as wide at apex as long ________ alaingens Davis.
3. Thorax at least dorsally red, adbomen largely black; wings fuscous. schizoceri Howard.
   Head and thorax mostly black or piceous, abdomen red ________ 4.
4. Thorax red dorsally; 5 mm ________ glabranotus Davis.
   Thorax black dorsally, sometimes more or less reddish ventrally; 8 mm.; wings deep black ________ nigripennis Cushman.

Subfamily Ophioninae.

OPHIONELLINI, new tribe.

Subfamily Pharsaliinae Szepligeti, Gen. Insect., fasc. 34, 1905, p. 3.

As pointed out by Brues[9] *Ophionellus* Westwood and (*Pharsalia* Cresson)=*Hymenopharsalia* Morley are probably distinct genera. The former is unknown to me. Of the latter the National Collection contains four species, two of which are new.

These two genera form a group in which the venation is very anomalous but not, I believe, of subfamily significance. Morley[10] has shown, though his terminology of the veins is very confusing, that what veins are present in the front wing are entirely analogous with those of (*Nototrachys*)=*Anomalon*. One feature of the venation which Morley overlooked, but to which Roman[11] calls attention,

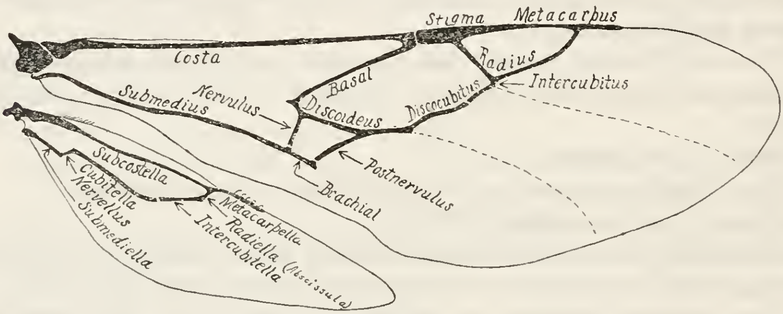

FIG. 1.—WINGS OF HYMENOPHARSALIA TEXANA (CRESSON).

is the movement of intercubitella far basad of its normal position for the Ichneumonidae, farther even than in the Cremastini. This together with the basal position of the nervellus gives the hind wing a strongly braconoid appearance. On the whole the venation (fig. 1) of this group is the extreme development of the form exhibited by *Anomalon* and the Cremastini. This consists in the retreating of the apical transverse veins toward the base of the wing with subsequent weakening of the apical abscissae of the longitudinal veins. Thus in various groups we have the second recurrent very close to, interstitial with, or even basad of the intercubitus; the very narrow base of the second discoidal cell, which in some cases at least seems to be due not so much to the upward movement of subdiscoideus as to the baseward movement of the postnervulus; and the great reduction of the basal abscissa of radiella (abcissula of Roman).

In the present group the baseward trend of the venation has gone so far that the apical abscissa of cubitus and the entire second recur-

[9] Ann. Ent. Soc. Amer., vol. 5, 1912, p. 202.
[10] Rev. Ichn. Brit. Mus., pt. 2, 1913, p. 97.
[11] Ent. voor Tidskr., 1910, p. 185.

rent and subdiscoideus have dropped out, although the longitudinal veins are represented by streaks. The position of the second recurrent is not even indicated (Morley to the contrary), for the bullation of discocubitus is distinct and there is apicad of this no angulation or thickening to indicate the possible position of recurrent. The postnervulus has moved back, the lower end even farther than the upper end, while the trace of subdiscoideus issues from the apex of discoideus instead of from its normal position at some point on postnervulus. The loss of practically the entire median vein in both front and hind wings is a secondary feature.

In the hind wing radiella is represented by a very short abscissula, nervellus is very close to the base, and mediella is missing, while all longitudinal veins apicad of intercubitella and the lower end of nervellus are lost.

Because of the deep mesopleural furrow and certain other characters Roman professes to see a tendency in *Pharsalia* toward *Gasteruption*, in which view I can not share. These features are, it seems to me, secondary developments rather than fundamental. The group is, in my opinion, entirely Ophionine in its relationship, but because of its very anomalous characters fully worthy of tribal rank, falling between the Therionini and (Nototrachini)=Anomalini and somewhat more closely related to the former through *Paranomalon* and *Labrorychus* than to the latter. About the only respect in which it resembles *Anomalon* more than *Paranomalon* is in the possession of only a single calcarium on the middle tibia. In the form of the head with its very broad occiput, which has a secondary carina encircling the cervical foramen; the flat or concave and strongly margined scutellum; the usually swollen hind tarsi; the very narrow stigma; the unswollen middle and front tibiae; the very long trochanters; and short ovipositor it is more like the Therionini.

Genus OPHIONELLUS Westwood.

Ophionellus Westwood, Thes. Ent. Oxon., 1874, p. 128, pl. 24, fig. 3.

In his description of *Ophionellus manni* Brues includes some characters that are apparently generic in significance, as follows: Frons with a deep impression which includes median ocellus; mesoscutum shining reticulate; scutellum flat; mesopleural groove coarsely reticulated.

Genus HYMENOPHARSALIA Morley.

Pharsalia Cresson, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 177. (Preoccupied by *Pharsalia* Thomson.)

Hymenopharsalia Morley, Rev. Ichn. Brit. Mus., Part 2, 1913, p. 97.

Parophionellus Brues and Richardson, Bull. Amer. Mus. Nat. Hist., vol. 33, 1913, p. 495.

The following characters, in addition to those listed by Brues for distinguishing this genus from *Ophionellus* Westwood, alternate with those given above under *Ophionellus:* Frons convex; mesoscutum opaque, coarsely, reticulately punctured, rarely with lateral lobes polished; scutellum concave; mesopleural groove polished above and more or less rugose below.

The following key includes all of the described species, except *Pharsalia albofacialis* Cameron, as well as two new species. Cameron's species, which is based entirely on a figure, was synonymized by Morley with *virginiensis* (Cresson) without any explanation of his reasons for so doing.

KEY TO SPECIES OF HYMENOPHARSALIA MORLEY.

1. Antennae white annulate **mexicana** Morley.
   Antennae not white annulate 2.
2. Head and lateral lobes of mesoscutum largely smooth 3.
   Head and lateral lobes of mesoscutum sculptured, the latter sometimes with a small polished area; hind basitarsus swollen 4.
3. Scape below and tegulae yellow; face black and yellow **annulipes** (Cameron).
   Scape and tegulae black; face entirely yellow; hind basitarsus not swollen. **schwarzi**, new species.
4. Clypeus strongly rounded at apex; face at clypeal foveae not more, usually less, than half as broad as frons and narrower than clypeus 5.
   Clypeus narrowly truncate at apex; face yellow, at clypeal foveae more than half as broad as frons and scarcely narrower than clypeus. **texana** (Cresson).
5. Face entirely yellow, about half as broad as frons; eyes with long dense hair **foutsi**, new species.
   Face more or less black; eyes with shorter sparser hair 6.
6. Mandibles, clypeus, and face except in middle yellow; hind tibia with a subbasal white annulus **virginiensis** (Cresson).
   Black without white or yellow markings except narrow inner orbits. **bridwelli**, new species.

HYMENOPHARSALIA MEXICANA Morley.

Hymenopharsalia mexicana Morley, Rev. Ichn., Part 2, 1913, p. 99.

The annulated antennae are very exceptional for the genus, while the entirely black face with yellow mouth and scape is very characteristic.

HYMENOPHARSALIA ANNULIPES (Cameron).

Pharsalia annulipes Cameron, Timehri: Journ. Roy. Agr. and Comm. Soc. Brit. Guiana, vol. 1 (ser. 3), 1911, p. 185.

The smooth head and lateral lobes of mesoscutum ally this species more closely to the next following species than to any of the others, while its yellow scape and tegulae readily distinguish it from any of the species except possibly *mexicana*. The latter and *texana* have the

scape yellow, but Morley does not give the color of the tegulae of *mexicana*, while in *texana* they are black.

HYMENOPHARSALIA SCHWARZI, new species.

At once distinguishable from any of the four following species by the unswollen hind basitarsus, the weakly sculptured vertex and lateral lobes of mesoscutum, and from all but *texanus* and *foutsi* by the entirely yellow face.

Female.—Length, 11 mm.; antennae, 4 mm.; front wing, 4 mm.

Head from above slightly wider than thorax; temples flat, about one-third as long as the shortest diameter of eye, densely clothed with long white pile; occipital carina nearly touching ocelli, obsolete in middle; secondary carina of occiput so strong that when head is viewed from above it appears bidentate on each side, the carina originating on each side very close to base of mandibles and apparently complete above cervical foramen; occiput polished and impunctate medially above; vertex smooth and subpolished with a few punctures between the ocelli; frons densely punctate in middle, smooth at sides; face polished but so densely covered with white pile that surface is obscured, scarcely half as wide below as at antennae; inner margins of eyes sinuately emarginate opposite antennae; malar space very short; clypeus as long as wide, its apex broadly subtruncate, mandible with a distinct tooth on lower margin at base of lower tooth, upper tooth hardly twice as long as lower; antennae longer than head and thorax, flagellum filiform, 23-jointed, first joint as long as second and third combined, middle joints more than twice as long as thick; furrow of pronotum sharply limited behind by a carina, foveolate in front and below, punctate behind, polished in middle; mesoscutum polished at sides, prescutum rugulose-punctate, notauli irregularly reticulate, lateral margins foveolate; mesopleural furrow transversely rugose below, polished above, with anterior and posterior margins more or less distinctly foveolate; mesosternum with a sharply defined longitudinal, glabrous, polished spot on each side; propodeum narrow, its sides not bulging, median furrow and lateral carinae distinct, reticulation almost obscured by pubescence, "neck" hardly reaching to middle of hind coxae; radial cell very small, shorter than apical abscissa of metacarpus; intercubitus distinct; hind basitarsus slender; hind coxae in their greatest thickness hardly a third as thick as long; abdomen opaque, very densely pubescent; ovipositor sheath as long as third tergite.

Black; face, clypeus, cheeks, mandibles, orbits opposite antennae, and a small spot near top of each eye behind yellow; antennae entirely black; tegulae black; wing venation brown; front and middle coxae, basal joint of their trochanters, and annuli at bases of their

tibiae and their tarsi largely, basal portion of basal joint of hind trochanter, annulus at base of hind tibia, and calcaria white; front legs otherwise pale testaceous; middle femur darker testaceous, its tibia and apex of tarsus piceous; hind leg largely piceous, extreme base of femur and apical joint of trochanter paler; abdomen black with sutures slightly reddish; sheath pale at base, blackish at apex.

Type locality.—Cacao, Trece Aguas, Alta Vera Paz, Guatemala.

Type.—Cat. No. 24621, U.S.N.M.

One specimen taken by Schwarz and Barber.

HYMENOPHARSALIA VIRGINIENSIS (Cresson).

Pharsalia virginiensis Cresson, Trans, Amer. Ent. Soc., vol. 4, 1872, p. 177.

Hymenopharsalia virginiensis Morley, Rev. Ichn. Brit. Mus., Part 2, 1913, p. 99.

Parophionellus virginiensis Brues and Richardson, Bull. Amer. Mus. Nat. Hist., vol. 33, 1913, p. 495. (By generic synonymy.)

This species is represented in the National Museum by two females from Falls Church (L. A. Stearns) and Glencarlyn (C. T. Greene), Virginia.

It is very similar in structure and color to *schwarzi* Cushman, but has the head strongly sculptured above; occipital carina strong medially, secondary carina weak; antennae not longer than head and thorax, thickened in the middle with the joints relatively much shorter; mesoscutum coarsely sculptured except small polished areas on the lateral lobes; pronotal and mesopleural furrows more extensively sculptured; propodeum more distinctly reticulated; apical abscissa of metacarpus barely half as long as radial cell; intercubitus obsolete; hind basitarsus distinctly swollen; ovipositor sheath shorter than third tergite; face and clypeus black medially; venation except on front margin of wing pale.

Pharsalia albofacialis Cameron, synonymized by Morley with this species, shows in the figure none of the characteristic leg markings of *virginiensis*, and since this figure is the only description of the species Morley's synonymy is unjustified. Moreover, Morley apparently did not know *virginiensis*, for he refers to this species specimens from Mexico and Brazil said to have the antennae half as long as the body, which they certainly are not in *virginiensis*. I am inclined to suspect that he had *Ophionellus fragilis* Westwood or *manni* Brues at least in his Brazilian specimen.

HYMENOPHARSALIA FOUTSI, new species.

More closely allied to *virginiensis* (Cresson) than to any of the other species, but distinguishable by its entirely yellow and broader face.

Female.—Length, 9.5 mm.; antennae, 3 mm.

Head about as long as broad; face at clypeal foveae nearly half as broad as frons; vertex closely punctate; secondary carina of occiput rather strong; antennae about a third longer than head and thorax, middle joints less than twice as long as thick. Mesoscutum without polished areas, reticulate-rugose medially and anteriorly, coarsely punctate laterally; pronotal furrow not carinate behind, transversely striate, as is also for the most part the mesopleural furrow; glabrous spots on mesosternum subopaque; propodeum rather short, its side seen from above strongly rounded, median furrow and lateral carinae distinct, reticulation obscure, "neck" reaching middle of hind coxae; apical abscissa of metacarpus about half as long as radial cell; intercubitus distinct; hind basitarsus swollen; hind coxae more than a third as thick as long. Abdomen opaque, pubescent; ovipositor sheath longer than third tergite.

Color as described for *schwarzi* except that scape is yellow beneath.

Type locality.—Glen Echo, Maryland.

Type.—Cat. No. 24622, U.S.N.M.

Two females, the type taken by R. M. Fouts July 31, 1917, and the paratype by J. C. Bridwell September 12, 1920, at the same locality.

HYMENOPHARSALIA BRIDWELLI, new species.

Female.—Length, 13 mm.; antennae, 5 mm.; front wing, 5 mm.

Distinct in its almost entire black color, the only pale markings being narrow brownish streaks on inner and upper orbits, while the front femora are piceo-testaceous. Structurally it is more closely allied to *virginiensis* and *schwarzi* than to *texana*.

Head from above not wider than the thorax, from in front longer than wide, the face below more than half as wide as at antennae, but much narrower than clypeus; face, clypeus, cheeks, and temples densely punctate; vertex and frons coarsely, reticulate-rugose; occiput polished throughout, the occipital carina not interrupted medially, the accessory carina obsolete; antennae longer than head and thorax; slightly thickened before middle and tapering thence toward apex; flagellum 25-jointed, middle joints less than twice as long as thick; mandible apparently not angulate on posterior margin; clypeus sharply rounded at apex with the margin slightly reflexed; lateral impression of pronotum roughened, not defined posteriorly by a carina; mesoscutum very coarsely reticulate-rugose, with a deep furrow posteriorly continuous with that of the scutellum; mesopleural furrow entirely transversely rugose; mesopleurum longitudinally reticulate-rugose under the dense pile, glabrous spot subopaque; scutellum deeply concave, punctate; propodeum with distinct longitudinal carinae and faintly reticulate, medially deeply reticulately furrowed, the "neck" reaching barely a third the length

of the hind coxae; hind tarsi distinctly thickened; apical abscissa of metacarpus nearly as long as radial cell; intercubitus obsolete; ovipositor sheath barely half as long as third tergite.

Entirely black except very narrow brownish inner and superior orbits, reddish front legs, bases of apical trochanter joints of middle and hind legs, and hind calcaria, and whitish front and middle calcaria; anterior margin of front wing, apical abscissa of discoideus, and metacarpella piceous, venation otherwise colorless.

Type locality.—Great Falls, Virginia.

Type.—Cat. No. 24623, U.S.N.M.

One female captured by J. C. Bridwell, July 5, 1920.

HYMENOPHARSALIA TEXANA (Cresson).

Pharsalia texana Cresson, Trans. Amer. Ent. Soc., vol. 4, 1872, p. 177.
Hymenopharsalia texana Morley, Rev. Ichn. Brit. Mus., 1913, p. 98.
Parophionellus texanus Brues and Richardson, Bull. Amer. Mus. Nat. Hist., vol. 33, 1913, p. 495. (By generic synonymy.)

Distinct in many ways from any of the other three species known to me. The face is much broader with eyes less strongly convergent; clypeus broad with the sides of the margin running obliquely down to the truncate apex; antennae barely as long as head and thorax, and stout; face strongly punctured; vertex densely punctured, the punctuation extending far down on the occiput and obscuring the occipital carina medially; pronotal furrow opaque and not defined by a carina behind; glabrous spot of mesosternum not so well defined and more in the form of a shallow furrow; propodeal "neck" more than half as long as hind coxae; sides of propodeum swollen; apical abscissa of metacarpus less than half as long as radial cell; intercubitella much more than twice as long as abscissula; hind basitarsus not only enlarged but distinctly swollen, being thicker in middle than at base or apex.

Entire face and orbits except at top of eye, clypeus, mandibles, and scape yellow; abdomen in middle and legs largely red.

There are 15 females and 5 males in the National Museum, from Texas, New Mexico, and Kansas.

The male has the hind tarsi even more swollen than the female; the outer genital valves are very slender, white at base, and black at apex.

Tribe CAMPOPLEGINI.

Genus OLESICAMPE Foerster.

To this genus should be referred *Homalomma pteronideae* Rohwer and *Prionopoda beginii* Ashmead.

CALLIDORA PALLIDA, new species.

Runs in Foerster's key to *Callidora*, though not agreeing with that genus in the form of the areolet. With Thomson's description of the

genus it disagrees in having the vertex rather broad transversely; the antennal annulus entire; thorax rather short and robust; areolet small, with recurrent beyond the middle; recurrent more strongly oblique; petiole not long and slender; second tergite short and broad, with spiracles at about the middle; postpetiole broader than long; legs rather stout. It should be noted that the two species referred to the genus by Thomson can not be run there in the original description because of the position of the spiracles of the second tergite, and neither can therefore serve as the genotype. The annulated antennae are so unusual in the Campopleginae and the species agree so closely otherwise with Foerster's description that there can be little doubt that they are properly referred to the genus.

It will be noted that all the differences noted above between the present species and Thomson's description, with the exception of the one color character, are differences of habitus and venation, which are of little importance in the Campoplegini. In the more important characters annulated antennae, strong costulae, and long calcaria it agrees with, and even exceeds Thomson's species, *Callidora annellata.*

Female.—Length, 8 mm.; antennae, 6 mm.

Head transverse; temples strongly sloping; vertex behind ocelli precipitous and medially impressed; vertex distinctly broader than face; face and clypeus granularly opaque, with dense white pubescence, separated by a very shallow, scarcely perceptible impression; clypeus with apex narrowly reflexed and broadly submarginate; malar space half as long as basal width of mandible; ocelli rather large, the ocellus, ocell-ocular line, and post-ocellar line in the ratio of 1:1:1.5; flagellum rather stout, attenuate at apex, densely pilose. Thorax, including propodeum, granularly opaque, short and thick, the propodeum extending only slightly over base of coxae; lateral impressions of pronotum and mesopleura transversely striate; mesoscutum very densely granular and densely white pubescent; propodeum transversely striate near apex; median area slightly concave; costulae strong; spiracles large, broadly oval; hind femora and tibiae rather stout, tarsi slender, barely as long as tibiae, basal joint as long as other four together, calcaria very long, inner one two-thirds as long as basitarsus; areolet small, nearly triangular, petiole longer than rest of first intercubitus; disco-cubitus without ramellus; second recurrent and nervulus inclivous, latter strongly postfurcal. Abdomen rather short and broad; petiole stout, postpetiole broader than long from spiracles, granular; second tergite broader at apex than long, with distinct, transversely oval gastrocoeli more than their length from base, spiracles at about middle; suture between second and third tergites constricted; apex of abdomen slightly compressed.

Ferruginous; face, clypeus, lower cheeks, scape and pedicel beneath, pronotum, scutellum and postscutellum yellowish; mandibles, annulus occupying flagellar joints 10–17, tegulae, and subalar spot white; legs testaceous, trochanters, front and middle tibiae basally, and all tarsi except apical joints white; wings hyaline, venation brown.

Type locality.—Montgomery County, Pennsylvania.

Type.—Cat. No. 24624, U.S.N.M.

One female captured June 21.

Tribe CREMASTINI.

(OLIGOTMEMA) DEMOPHORUS PRIMA Cushman.

Since the description of this genus and species was written I have found in the miscellaneous material in the National Museum 3 additional females and 54 males. These are all from the Baker collection and all from Colorado.

The male differs from the female practically only in the form of the abdomen. In the male this is narrower and has the tergites beyond the third less strongly retracted, though together not much longer than the third.

I am indebted to Dr. A. Roman, to whom paratypes of this species were sent, for the correct placing of the species in *Demophorus* Thomson.

CREMASTUS (ZALEPTOPYGUS) CHAMPLAINI, new species.

Because of the entirely ferruginous coxae this species will not run in my key [12] to the neighborhood of its closest relative, *dorcaschemae* Cushman.

The most striking differences between this and *dorcaschemae* are found in the clypeus and the petiole of the abdomen. In the present species the clypeus is elevated medially just before the apex, sometimes almost conically, and impressed laterally (in *dorcaschemae* there is the merest trace of this structure). In *champlaini* the petiole is much more distinctly decurved than in *dorcaschemae.*

Female.—Length. 10 mm.; antennae, 6.5 mm.; ovipositor, 2.5 mm.

Head from above transversely oblong, the temples straight for a short distance, then rather suddenly changing to nearly perpendicular to the longitudinal axis of body; from in front transversely suboval, distinctly broader than long, with the eyes large and prominent, but separated by their own greatest length and slightly divergent below; head opaque, sparsely and finely punctate on frons, vertex, and temples, more densely and coarsely so on face; clypeus shining, very weakly and sparsely punctate; malar space two-thirds basal width of mandible; diameter of ocellus and postocellar and

[12] Proc. U. S. Nat. Mus., vol. 53, 1917, pp. 511–516.

ocell-ocular lines about equal. Thorax elongate, subcylindrical, the propodeum extending nearly to middle of hind coxae, subopaque and rather sparsely punctate, more densely so on mesoscutum and scutellum; pronotum polished in the scrobes, as is also the speculum; propodeum transversely rugose except basal lateral areas, which are subpolished and sparsely punctate, carinae very strong, in profile strongly angularly curved from base to apex, areola fully as long as petiolar area; stigma broad with radius beyond middle; metacarpus slightly longer than stigma; basal vein nearly straight and forming an acute angle with the median; second discoidal cell much longer than the first brachial; upper abscissa of postnervulus little more than half as long as lower; mediella obsolete basally nearly to nervellus; legs rather stout, hind tarsus but slightly longer than tibia, coxae opaque shagreened and sparsely punctate. Abdomen rather stout; first tergite much longer than second, distinctly decurved, petiole flattened above and below, laterally with a deep foveolate groove, merging gradually with postpetiole which is flattened with a distinct impression dorsally just before spiracles; postpetiole and second tergite longitudinally aciculate; other tergites opaque shagreened with very minute sparse punctures; ovipositor sheath one and a half times as long as first tergite.

Black; orbits, narrowly interrupted on vertex and at sides of face, clypeus laterally at apex, mandibles, tegulae, and wing radices yellow; legs ferruginous, hind tibia and tarsus fuscous, femur pale at apex; wings hyaline, smoky at apex, veins fuscous, stigma paler; antennae entirely black.

Male.—Length, 9 mm.; antennae, 7 mm.

Except that the antennae are relatively longer, the orbits more broadly yellow and uninterrupted except very narrowly on vortex, the clypeus more strongly elevated and more extensively yellow, the ocelli distinctly longer than the ocell-ocular line, and the abdomen more slender, very like the female.

Host—Elaphidon? in *Cercis canadensis.*

Type locality.—Rockville, Pennsylvania.

Type.—Cat. No. 24625, U.S.N.M

Described from three females and four males reared by A B. Champlain and J. N. Knull. One paratype of each sex is returned to the Pennsylvania Bureau of Plant Industry, Harrisburg.

The size varies from 10 to 8 mm., paratype *a*, female, being the smallest.

Family BRACONIDAE.

UROSIGALPHUS CRASSISCULPTUS, new species.

Distinct from all other species having the interocellar space elevated by its very gross sculpture, very high thornlike vertical elevation, and piceous legs.

Male.—Length, 6 mm. Head broad behind eyes, the temples weakly sloping; vertical prominence very high, in profile thin at apex and thornlike; vertex and temples coarsely punctate, the vertex very grossly so; frons reticulate punctate; face very coarsely and unevenly rugose with more or less distinct interspersed punctuation; clypeus transversely rugose with some punctures; labium densely coarsely punctate, truncate at apex; malar space as long as basal width of mandible; antennae 16-jointed. Thorax very grossly sculptured; pronotum with large round punctures becoming elongate and foveiform along dorsal and posterior margins; mesoscutum reticulate rugose except in middle of each of the three lobes, where it is polished with some fine punctures, prescutum divided medially by an irregular ridge; scutellum and dorsal and lateral faces of propodeum reticulate rugose; mesopleurum except centrally coarsely foveate rugose, centrally polished, the foveae of the oblique impression long and foveolate, mesosternum largely foveate, rugose but with a small triangular polished and punctate area on each side of middle; posterior face of propodeum perpendicular, coarsely punctate. Abdomen coarsely reticulate rugose, apically with two teeth about twice as high as their basal thickness; outer gonapophyses short, straight.

Black; legs piceous; wings subhyaline, slightly infumate in apical half.

Type locality.—Agricultural College, Michigan.

Type.—Cat. No. 24627, U.S.N.M.

Described from three males.

UROSIGALPHUS BARBERI Crawford.

About 35 additional specimens from such widely separated locali ties as Orange, New Jersey; Washington, District of Columbia; Arlington and Fort Monroe, Virginia; Boerne and Brownwood, Texas; and Pachico Pass, California, seem all to belong here. There is considerable variation in sculpture, size, apparent length of ovipositor, number of antennal joints, and position and size of the abdominal tubercles. Nearly all of the specimens were reared at the Bureau of Entomology from various species of *Balaninus* in acorns.

It agrees with *crassisculptus* Cushman and differs from *armatus* Ashmead in having the hind legs short, the femur not reaching the apex of the abdomen, and the tarsus shorter than the tibia with short, thick joints; face nearly twice as wide as greatest diameter of eye; abdomen in female tuberculate at apex; ovipositor not or barely longer than the body; and the outer gonapophyses in the male very slender and nearly straight, not strongly curved near apex as in *armatus*.

From *crassisculptus*, in addition to the characters mentioned under that species, it differs principally in having the outer gonapophyses in the male very long and conspicuous.

UROSIGALPHUS ARMATUS Ashmead.

In addition to the types, there are four females and one male of this species in the National Collection, mostly associated with chestnut or chinquapin (*Castanea dentata* and *Castanea pumila*), three of the females having been reared from *Balaninus*, probably *proboscideus*.

As in *barberi* there is considerable variation in size, sculpture, and length of ovipositor, the last, however, being always much longer than the body. In the female it is also at once distinguishable from its nearest relatives by the lack of apical abdominal tubercles, and in the male by the long curved outer gonapophyses.

Pierce [13] writes that he has seen specimens of this species in the National Museum from West Virginia reared from *Conotrachelus*, but no such specimens are to be found either under this or any other name.

Chittenden [14] writes that this species attacks all of the common species of *Balaninus*. Most of the specimens on which this statement is based, however, have been examined and with one exception prove to be *barberi* Crawford.

UROSIGALPHUS FEMORATUS Crawford.

Additional specimens are from Washington, District of Columbia; Cedar Point, Maryland; Southern Illinois (Robertson); Onaga, Kansas (Crevecoeur); and Victoria, Texas (J. D. Mitchell). The Washington specimen was reared under Hunter No. 1334 as a parasite of *Tyloderma foveolatum* in the stem of evening primrose.

UROSIGALPHUS NEOMEXICANUS Crawford.

There is an additional female from the type locality and also a male taken at Dallas, Texas, on *Salvia lanceolata*, by F. C. Bishopp.

UROSIGALPHUS OTIDOCEPHALI, new species.

Runs in Crawford's key [15] to *hubbardi* Crawford, agreeing in all the key characters except size.

Male.—Length, 3 mm. Head shining, sparsely punctate, most distinctly so on vertex; frons with a median groove which extends downward well beyond antennae and ends in a small pit; vertex be-

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[13] Journ. Econ. Ent., vol. 1, 1908, p. 386.
[14] Bur. Ent. Bull. 44, 1904, p. 33.
[15] Ins. Ins. Mens., vol. 2, 1914, p. 22.

tween ocelli not elevated; clypeus coarsely punctate, with a reflexed margin; malar space longer than basal width of mandible; antennae barely as long as head anad thorax, 16-jointed. Thorax shining; pronotum coarsely punctate; mesoscutum obscurely and minutely punctate, medially foveatae-punctate; scutellum not elevated at apex, reticulate with two large more or less distinct foveae at apex, the furrow quadrifoveate; mesopleurum reticulate above and below, polished in middle, the posterior groove foveolate; metapleurum and propodeum reticulate, the latter divided into superior and posterior faces by a prominent carina, the posterior face more finely sculptured and with a median irregularly cordate area set off by a carina; legs stout, the hind femur not reaching apex of abdomen; radial cell acute at apex. Abdomen longitudinally striate for about two-thirds its length, the interspaces and the apex punctate, without tubercles at apex.

Black; front and middle legs, hind trochanters, and base of tibia testaceous to ferruginous, hind legs otherwise black; antennae basally and mandibles ferruginous.

Host.—*Otidocephalus* in Sycamore.

Type locality.—Harrisburg, Pennsylvania.

Type.—Cat. No. 24628, U.S.N.M.

Since the above description, based on five males reared by A. B. Champlain and J. N. Knull, of the Pennsylvania Bureau of Plant Industry, Harrisburg, was set in type, nine additional males and seven females have been received from Mr. Champlain. The female differs in no important particular from the male. The ovipositor extends beyond the apex of the abdomen a little more than a third the length of the abdomen.

Five paratypes are returned to the Pennsylvania Bureau of Plant Industry, Harrisburg.

UROSIGALPHUS PINI, new species.

Closely allied to *otidocephali* Cushman, from which it may be distingushed at once by the red hind femora.

Male.—Length, 3 mm.

Compared with *otidocephali* it differs further as follows: Temples nearly as wide as the eyes for a short distance; scutellum more finely sculptured, not bifoveate apically; punctuation of mesopleurum finer and more extensive, the speculum being reduced to a small subcircular area slightly cephaled of the middle; radial cell obtuse at apex; longitudinal rugae of abdomen less prominent and more confused; legs ferruginous, hind coxae, tibiae, and tarsi piceous.

Type locality.—Patrick's Creek, California.

Type.—Cat. No. 24629, U.S.N.M.

One specimen collected September 14, 1916, on *Pinus attenuata* by J. E. Patterson. (Hopkins U. S. No. 14289f.)

PHANEROTOMA ZETEKI, new species.

Female.—Length, 4.5 mm.; antennae, 4.0 mm.

Head from above transverse, the occiput very deeply and broadly concave, temples strongly convex; eyes very prominent, nearly hemispherical; ocellar triangle nearly as broad as ocell-ocular line; malar space two-thirds of basal width of mandible; clypeus deeply separated medially, with two indistinct teeth on apical margin; head generally densely, finely punctate, temples and cheeks more sparsely so, clypeus practically impunctate; lower tooth of mandible nearly as long as upper; antennae with more than 30 joints, scape barely twice and first joint of flagellum three times as long as thick, joints toward apex very short moniliform. Thorax dorsally densely punctate, scutellum more sparsely so and polished, mesoscutum medially rugose; notauli well defined, complete; pleura minutely rugoso-punctate, with a poorly defined longitudinal furrow; propodeum irregularly rugose, the areolation poorly defined, angulate posteriorly; hind legs, especially the tibiae, stout, the tarsus shorter than the tibia; radiella obsolete to base. Carapace longitudinally striate, flattened and truncate at apex, first tergite longest, third slightly longer than second; hypopygium extending distinctly beyond apex of carapace; ovipositor exserted.

Flavous, head more ferruginous, with the following black or blackish markings: stemmaticum, middle of mesoscutum, spot above base of wing, apex of tegula, scutellum, postscutellum, most of propodeum, hind tibia at base and apex with a line down each side, and a large spot covering most of the third tergite and the apical middle of second; wings hyaline, stigma, radius, first intercubitus, and basal abscissa of cubitus and junction of discoideus and nervulus fuscous, the stigma paler at apex, venation otherwise ferruginous to stramineous; a broad yellow stain at junction of basal vein with parastigma; legs stramineous.

Male.—Differs only in sexual characters.

Type locality.—Corozal, Canal Zone, Panama.

Type.—Cat. No. 24630, U.S.N.M.

Four females and one male reared (host not indicated) by Mr. J. Zetek.

PHANEROTOMA UNIPUNCTATA, new species.

Female.—Length, 7.0 mm.; antennae (broken).

Head from above nearly subquadrate, the occiput deeply concave, temples very strongly convex; eyes very prominent hemispherical; ocellocular line nearly twice as broad as ocellar triangle; malar space two-thirds basal width of mandible; clypeus indistinctly separated medially, with three distinct teeth on apical margin; vertex and face rugose; clypeus and temples punctate, the former very finely so;

lower tooth of mandible very short; scape nearly three times and first joint of flagellum about six times as long as thick. Mesoscutum rugulose punctate, rugose in middle, notauli poorly defined; scutellum sparsely punctate; pleura reticulate above, sparsely punctate, the longitudinal furrow poorly defined; propodeum reticulate; the areolation rather well defined, angulate posteriorly; middle tibia with a distinct swelling above basad of middle; hind tibia stout, hardly longer than tarsus; radiella distinct, though weak. First and second tergites longitudinally striate, third finely reticulate punctate, strongly arched and roundly emarginate at apex; third tergite much the longest, first slightly longer than the second; hypopygium not reaching apex of carapace; ovipositor slightly exserted.

Flavous with following markings in brown to black: Middle of vertex and frons and spot behind top of each eye (brown), median spot on mesoscutum, scutellum, postscutellum, spot above base of each wing, apex of tegula, all tibiae, base of middle and hind tarsi, and a large spot in middle of second tergite. Wings hyaline with an obscure cloud from basal vein nearly to apex, venation stramineous except stigma, discoideus, brachius, and nervulus, which are fuscous; apical two-thirds of hind wing clouded.

Type locality.—Manaos, Brazil.

Type.—Cat. No. 24631, U.S.N.M.

One specimen taken by Miss H. B. Merrill.

VELARDEÑITE FROM A NEW LOCALITY IN TULARE COUNTY, CALIFORNIA.

By Earl V. Shannon,
Assistant Curator, Department of Geology, United States National Museum.

INTRODUCTION.

Dr. Esper S. Larsen recently forwarded to this department for accession and chemical investigation some specimens which had been received at the United States Geological Survey from Tulare County, California. (Cat. No. 94342, U.S.N.M.) These specimens, which when received were labeled "uranium ore," were examined optically by Doctor Larsen and found to be composed chiefly of a mineral of the melilite group. This mineral has since been analyzed in the Museum laboratory and proves to consist largely of the end member of the melilite group named velardeñite by Schaller. The California material is very similar in composition to that from Velardeña, Mexico, upon which the species velardeñite was instituted.

PHYSICAL PROPERTIES AND ASSOCIATED MINERALS.

In the hand specimen the material is coarse-granular and is dull olive-green in color except near certain narrow veins about .3 mm. in thickness which traverse the specimens. These veins are filled with a white porcellanous material, on either side of which for a space of about 5 mm. the color of the velardeñite is pitch-black. An occasional grain shows well-defined cleavage. The luster is greasy to resinous. Under a lens the specimen is seen to be dotted with small grains of garnet which have a yellow-green color, which distinguishes them from the duller green velardeñite.

In this section the velardeñite makes up a fabric of coarse interlocking grains. It is colorless except near the narrow veinlets. The latter are white and practically opaque under the microscope and probably consist of cryptocrystalline silica. Near them the velardeñite is thickly dusted with a very finely disseminated brownish-black material. The larger grains of velardeñite frequently show a well-defined cleavage in one direction with a rather perfect parting at right angles to the cleavage. Scattered throughout the section are small irregular grains of isotropic yellow-green garnet. These occur both as irregular tongue-like grains between the crystals of velardeñite and as small inclusions in the crystals of velardeñite. The garnet grains inclosed in the velardeñite crystals are in many in-

stances crudely rectangular, their borders coinciding with the cleavage and parting of the surrounding velardeñite. In less amount there occurs intergrown with the garnet and also disseminated in grains in velardeñite, another isotropic mineral having a pale brown color in thin section. This has an index of refraction slightly lower than that of the garnet and is doubtless spinel. The total volume of the minerals other than velardeñite in the specimens is less than 5 per cent of the whole. The only other mineral identified is magnetite, which occurs in disseminated euhedral grains.

OPTICAL PROPERTIES.

The velardeñite is colorless as seen under the microscope. It is uniaxial and negative. The indices of refraction as determined by immersion are:

$$\omega = 1.657 \pm .002$$
$$\epsilon = 1.653 \pm .002$$
$$\omega - \epsilon = .004 \pm .002$$

In thin section the mineral polarizes in grays, in sections of approximately .03 mm. thickness. Where garnet occurs in the velardeñite, however, there is a halo in the velardeñite around the garnet grains which has higher birefringence as though some constituent of the garnet had diffused into the other mineral for a short distance and had increased its birefringence.

CHEMICAL PROPERTIES.

The mineral is readily soluble in acids with separation of gelatinous silica. Pure material for analysis was secured by separation with heavy solutions. Upon analysis this purified material gave the results tabulated in column 1 below. In column 2 are given the figures obtained by E. T. Allen upon the material from Velardeña, Mexico, described by Wright.[1]

Analyses of Velardeñite from California and Mexico.

	(1) California.	(2) Mexico
SiO_2	27.88	26.33
TiO_2	....	.03
Al_2O_3	25.52	27.82
Fe_2O_3	1.59	1.43
FeO	.43	.50
MnO	....	.01
MgO	4.18	2.44
CaO	40.86	39.55
Na_2O	....	.21
K_2O	....	.10
H_2O	.34	1.85
	100.80	100.27

[1] Wright, F. E., Amer. Journ. Science, vol. 26, p. 547, 1908.

The analysis of the California material gives the following ratios:

Ratios of Velardenite from California.

SiO_2	.4623	46.23	.99× 9
Al_2O_3	.2497	25.97	1.00× 5
Fe_2O_3	.0100		
FeO	.0060	73.45	1.01×14
CaO	.7285		
MgO	.1032	10.32	1.00× 2

The composition of the material is thus capable of expression by the formula $14CaO.2MgO.5Al_2O_3.9SiO_2$. The velardeña material was interpreted by Schaller[2] as an isomorphous mixture of åkermanite, for which he adopted the formula $4MgO.8CaO.9SiO_2$, and velardeñite to which he assigned the formula $2CaO.Al_2O_3.SiO_2$. Taking the present mineral as of similar constitution and using the magnesia as an index to the åkermanite present it gives:

	28 CaO.	4MgO.	10 Al_2O_3.	18SiO_2	
minus	8 CaO	4MgO.		9SiO_2	åkermanite
leaves	20 CaO.		10 Al_2O_3.	9SiO_2	

Taking for the formula for åkermanite the $2CaO.MgO.2SiO_2$ found by Ferguson and Merwin[3] the following results are obtained:

	14 CaO.	2MgO.	5Al_2O_3.	9SiO_2	
minus	4 CaO.	2MgO.		4SiO_2	åkermanite × 2.
leaves	10 CaO.		5Al_2O_3.	5SiO_2.	
or	2 $CaO.Al_2O_3.SiO_2$×5				velardeñite.

It thus appears that the California mineral consists of velardeñite and åkermanite in the ratio of 5 parts of the former to 2 of the latter or of 71.6 per cent by weight of velardeñite and 28.4 per cent of åkermanite. Schaller calculated that the Mexican material contained 80 per cent of velardeñite and 20 per cent of åkermanite.

The artificial compound $2CaO.Al_2O_3.SiO_2$ was first prepared artificially by Weyberg and later by Shepherd and Rankin. Schaller, in his theory of the melilite group,[4] showed that all of the chemical peculiarities of the various members of the group could be explained by interpreting the minerals as isomorphous mixtures of four end members, namely, sarcolite ($3CaO.Al_2O_3.3SiO_2$), a theoretical soda sarcolite ($3Na_2O.Al_2O_3.3SiO_2$), velardeñite ($2CaO.Al_2O_3.SiO_2$), and åkermanite ($4MgO.8CaO.9SiO_2$). The end member velardeñite was found to occur in excess in material called gehlenite from several localities, but since the name gehlenite had obviously been given to an intermediate mixture of two or more end members it was recommended that this name be discarded. This series of minerals has

[2] Schaller, W. T., Bull. U. S. Geol. Survey No. 610, p. 106, 1916.
[3] Ferguson, J. B., and Merwin, H. E., Proc. Nat. Acad. Sci., vol. 5, p. 18, 1919.
[4] Schaller, W. T., U. S. Geol. Surv. Bull. 610, pp. 106–129, 1916.

been extensively investigated by the geophysical laboratory of the Carnegie Institution of Washington, and their results have, in the main, confirmed Schaller's theory as to the constitution of the group and the composition of the end members. A discrepancy in nomenclature has arisen, however, which is very confusing. This is due to the fact that the men working on the synthetic compounds of this group have disregarded the name velardeñite and have transferred the name gehlenite to this compound. Until some explanation is advanced to justify the deviation from the nomenclature of Schaller, to whom we are indebted for the correct interpretation of the melilite group, natural minerals approaching the pure end member $2CaO.Al_2O_3.SiO_2$ may correctly be called velardeñites.

COMPOSITION OF THE GARNET.

A small amount of a concentrate, consisting largely of the garnet which occurs associated with the velardeñite, was isolated with heavy solutions. The portion was small, and in addition to the garnet contained also spinel, which is almost identical with the garnet in specific gravity. One portion only was available, and the state of oxidation of the iron was not determined. It is below assumed to be entirely in the ferric state. An analysis of this small portion of material gave the following composition and ratios:

Analysis and ratios of garnet (with spinel).

Constituent.	Per cent.	Ratios.		
SiO_2	32.66	0.5416	54.16	0.90×3
Fe_2O_3	24.15	.1512	20.94	1.04×1
Al_2O_3	5.95	.0582		
CaO	35.51	.6331	69.73	1.16×3
MgO	2.59	.0642		

The ratios are not satisfactorily close to whole numbers, thus indicating a considerable admixture of spinel. Assuming the greater part of the magnesia and alumina to be present in this form, it is evident that this yellow-green garnet is very largely composed of the lime-ferric iron molecule andradite.

LOCALITY AND OCCURRENCE.

The locality for the material is not known more definitely than simply Tulare County, California, and no information regarding the occurrence is available other than that furnished by the specimens themselves. It seems most probable that the velardeñite and associated minerals are here, as in Mexico, products of the contact metamorphism of limestone.

A NEW DESCRIPTION OF SANIWA ENSIDENS LEIDY, AN EXTINCT VARANID LIZARD FROM WYOMING.

By Charles W. Gilmore,
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INTRODUCTION.

In 1870 Dr. F. V. Hayden discovered the fossil remains of an extinct lizard in the Bridger deposits, Eocene, in the vicinity of Granger, Sweetwater County, Wyoming, which Dr. Joseph Leidy briefly described[1] as *Saniwa ensidens.*

The type specimen was deposited in the United States National Museum, where it has remained in the same unprepared condition as originally received 50 years ago. It was preserved in a considerable number of blocks of ash-colored rock, the only evidence of the embedded specimen being two vertebrae, which had been uncovered, and the numerous bones which protruded from the broken faces of the rock.

Recently this specimen has been fully prepared by Mr. N. H. Boss, preparator in the Section of Vertebrate Paleontology, and under his skillful manipulation all the contained bones have either been entirely freed from the matrix or worked out in bold relief. This work has resulted in uncovering many elements whose former existence was unknown, and especially important was the discovery of a considerable part of the vertebral column and the greater portion of the skull and lower jaws.

Since paleontology as yet affords very little information concerning the evolution of the more specialized land lizards, the unusual perfectness of the skeletal remains of the present specimen, coupled with the fact that *Saniwa ensidens* was the very first extinct lacertilian lizard to be described from North America, it is of sufficient interest to warrant a full and detailed description of the type specimen.

[1] Proc. Acad. Nat. Sci., Phila., 1870, p. 124.

OSTEOLOGY OF SANIWA.

Suborder SAURIA.

Family VARANIDAE.

Genus SANIWA Leidy.

SANIWA ENSIDENS Leidy, 1870.

Saniwa ensidens LEIDY, Proc. Acad. Nat. Sci. Phila., 1870, p. 124; U. S. Geol. Surv. of Wyo. and contiguous Terr., 2nd (4th) Ann. Rept. F. V. Hayden, U. S. Geologist, 1871, p. 368; U. S. Geol. Survey of Montana and portions of adjacent Terr., F. V. Hayden, U. S. Geologist, Washington, D. C., 1872, p. 370.—KING, C. U. S. Geol. Explor. 40th parallel, Clarence King, Geologist in charge, 1878, vol. 1, p. 608.—HAY, O. P. Bull. 179, U. S. Geol. Survey, 1901, p. 475.

Saniva ensidens (Leidy), MARSH, O. C. American Jour. Sci., ser. 3, 1871, p. 457.—COPE, E. D. U. S. Geol. Survey Terr. for 1872, 6th Ann. Rept., F. V. Hayden, U. S. Geologist, Washington, D. C., 1873, p. 632.—LEIDY, J. Report of U. S. Geol. Survey of Terr., F. V. Hayden, U. S. Geologist in charge, vol. 1, 1873. pp. 181–344, pl. 15, fig. 15; pl. 17, fig. 35.—NOPCSA, F. B. Beitr. Z. Kenntn, foss. Eid., Beitr. Z. Pal. U. Geol. Ost. Ung., vol. 21. Wien, U. Leipzig, 1908, p. 46.—FÉJÉRVÁRY, G. J. Ann. Müsei Nationalis Hungarici, vol. 16, 1918, p. 420.

Type specimen.—Cat. No. 2185, U.S.N.M. Collected by Dr. F. V. Hayden, 1870.

The following list shows the bones preserved of the type specimen:

Skull.—Basioccipital; basisphenoid; supraoccipital; exoccipital, right and left; opisthotic, right and left; prootic, left; postfrontal, right and left; postorbital, right and left; prefrontal, left; maxilla, right and left; lachrymal, left; jugal, left (?); quadrate, left; epipterygoid, right fragment and left; pterygoid, right and left; ectopterygoid, right and left; palatine, right and left; vomer, right and left; several teeth.

Lower jaw.—Dentary, right and left; splenial, left in part; articular + prearticular, right and left; angular, right and left; surangular, right and left; coronoid, right.

Vertebrae.—Atlas, axis, third, fourth, fifth, sixth, and seventh cervical vertebrae, articulated; eighth, ninth, tenth, and eleventh vertebrae, articulated; twelfth to twenty-first vertebrae, partially articulated; 13 caudal vertebrae.

Ribs.—Thoracic ribs (8 fairly perfect, parts of 10 others).

Limb bones.—Right humerus; femur, distal portion, left; tibia, distal portion, left.

Pectoral girdle.—Right coracoid.

Type locality.—Vicinity of Granger, Sweetwater County, Wyoming.

Horizon.—Bridger formation, Middle Eocene.

The original description by Leidy is as follows:

Saniwa ensidens.—Among the fossils obtained in Professor Hayden's expedition are the remains of a lacertian, labeled as having been discovered near "Granger." The bones consist of those of most parts of the skeleton, but are

all in a fragmentary condition, and are embedded in freshly broken pieces of an ash-colored rock. Before disturbance they appear to have been mostly entire and preserved nearly in conjunction. They are black, and their interior is occupied with crystalline calcite.

Fragments of bones exhibit well-developed limbs, with long toes, strong ribs, and a long tail, altogether indicating a form like that of ordinary living lacertians. The long bones, even to those of the toes, are hollow. The vertebrae exhibit the ball-and-socket articulation of their bodies, but only a single pair of zygapophyses in front and behind. No zygantral and zygosphenal articulation appears to have existed.

The articular ball of the vertebral body is much wider than high, and is directed upward, with an inclination backward.

The body of several dorsals is quite straight inferiorly, fore and aft, and measures half an inch in length. The ball is four lines wide and about half as thick. The breadth at the anterior zygapophyses is eight lines, and at the articulations for the ribs, just exterior to the latter, three-fourths of an inch.

Hypophyses for the articulation of chevrons are situated one-fourth the length of the body from the posterior extremity.

A tooth was found, after careful search, in proximity to what appear to be traces of the skull. It consisted of the crown, broken from its connection, the character of which, therefore, can not be ascertained.

The crown of the tooth is compressed conical, slightly curved inwardly and backward, sharp pointed, with abruptly impressed trenchent borders; is smooth and shining. It is hollow and has thick walls. The transverse section is rhomboidally oval, with acute poles. The length is about 1¼ lines; the breadth three-fourths of a line; thickness one-half a line.

The remains would indicate an animal as large as the largest of our living iguanians.

For the generic name of the animal I would propose to use the euphonious one of Saniwa which, according to Professor Hayden, is that used by one of the Indian tribes of the Upper Missouri for a rock lizard. The species may be named *Saniwa ensidens.*

DESCRIPTION OF THE TYPE SKELETON OF SANIWA ENSIDENS, LEIDY.

SKULL.

It will be seen from an examination of the preceding list of the bones preserved of the type of *Saniwa ensidens* Leidy that a very considerable part of the skull and lower jaws has been preserved. Most of these bones, excepting the palate shown in plate 1, were found disarticulated, though none of the bones were far removed from one another in the matrix. Curiously enough the larger and heavier elements of the skull, such as the parietals, frontals, nasals, and premaxillaries, are entirely missing. It is also unfortunate that the anterior ends of the articulated maxillaries and vomers, as well as the symphysial ends of the dentaries, are wanting. These parts extended into another block of the matrix, which was either rejected in the field or has since been lost.

The skull of *Saniwa*, as may well be inferred from the close resemblance of the various elements to those of the *Varanus*, had the same light, open construction as in that genus. The similarity of many of the individual bones is remarkable, especially when the Eocene age of the fossil is taken into consideration.

A skeleton of *Varanus salvator* (Cat. No. 29551, U.S.N.M.), having a skull of practically the same dimensions as the type of *Saniwa ensidens* Leidy, has a greatest length of (473 mm.) 4 feet 10 inches. I am of the opinion that the length of the complete skeleton of the fossil specimen would be somewhat less, because of the slightly smaller and shorter vertebrae, but it would certainly have exceeded 4 feet in length. Some of the extinct American species as *Saniwa major* Leidy or *Thinosaurus grandis* Marsh probably rivaled the largest of the existing Monitors (*Varanus salvator*), which often

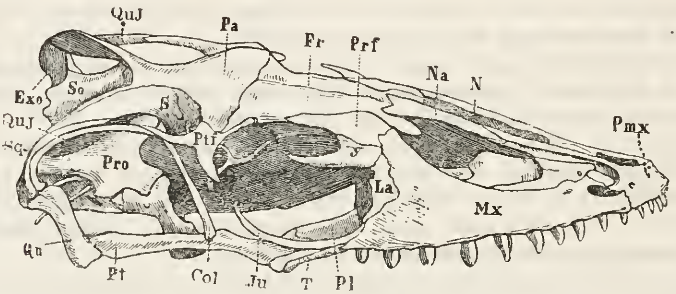

FIG. 1.—SKULL OF VARANUS NILOTICUS. *Col*, COLUMELLA; *Exo*, EXOCCIPITAL; *Fr*, FRONTAL; *Ju*, JUGAL; *La*, LACHRYMAL; *Mx*, MAXILLARY; *N*, EXTERNAL NARES; *Na*, NASAL; *Pa*, PARIETAL; *Pl*, PALATINE; *Pmx*, PREMAXILLARY; *Prf*, PREFRONTAL; *Pro*, PROOTIC; *Pt*, PTERYGOID; *Ptf*, POSTFRONTAL + POSTORBITAL; *Qu*, QUADRATE; *Quj*, QUADRATOJUGAL; *S*, SUPRATEM-ORAL FOSSA; *So*, SUPRAOCCIPITAL; *Sq*, SQUAMOSAL; *T*, ECTOPTERYGOID; *Y*, SUPRAORBITAL. (AFTER CUVIER.)

attains a length of 7 feet. The largest of the American species, however, are small as compared with the *Megalania prisca* from the Pleistocene of Australia with an estimated[2] length of 30 feet for the entire animal.

Basioccipital.—The basioccipital is perfectly preserved, except for the loss of its posterior median portion, which with the exoccipitals forms the occipital condyle. It thus forms the median boundary of the base of the foramen magnum, and ventrally is continuous laterally with the exoccipitals, which, as in *Varanus*, develop thin winglike plates that extend forward in a horizontal plane from the ventral sides of the proximal ends. The anterior, transversely broad, wedge-shaped end is received in a corresponding transverse depression on the posterior end of the basisphenoid. The dorsal surface of the basioccipital is medially depressed, forming a wide longitudinal valley.

[2] Lydekker, R. Cat. of Fossil Reptilia and Amphibia, Pt. L, 1888, p. 284.

Basisphenoid.—The basisphenoid of *Saniwa* as in living lizards generally sends downward two short processes or hypophyses with flattened expanded ends that abut against the pterygoids, as in *Varanus* (fig. 1). Between these processes at the middle it is drawn out in front into a short truncated rostrum which articulated with the presphenoid. The posterior margin is broadly notched for the articulation of the basioccipital. The dorsal surface slopes upward from the back toward the front, this inclination being continued on either side as divergent projecting processes which in the articulated skull are lapped by a slender projecting process of the proötic. Between, and ventral to these two processes the widened anterior end of the bone is deeply and broadly scooped out, forming the *sella tertica*, into which a pair of entocarotid canals open. On the lateral posterior surface is a foramen that in *Varanus* leads diagonally through the wall of bone into the median excavation described above. This bone in size and shape is remarkably similar to the basisphenoid of *Varanus salvator* (Cat. No. 29408 U.S.N.M.).

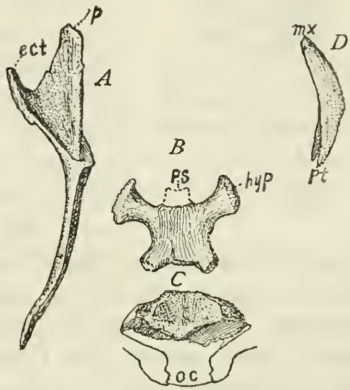

FIG. 2.—VENTRAL VIEW OF SKULL BONES OF SANIWA ENSIDENS LEIDY. CAT. NO. 2185. U.S.N.M., TYPE. ALL NATURAL SIZE. A, RIGHT PTERYGOID. *Ect*, PROCESS ARTICULATING WITH THE ECTOPTERYGOID; *p*, PROCESS THAT UNITES WITH THE PALATINE. B, BASISPHENOID; *hyp*, HYPOPHYSES; *ps*, PRESPHENOID, WHICH IS MISSING. C, BASIOCCIPITAL; *oc*, OCCIPITAL CONDYLE RESTORED. D, RIGHT ECTOPTERYGOID, DORSAL VIEW; *mx*, ANTERIOR END THAT MEETS THE MAXILLARY; *pt*, POSTERIOR BIFURCATED END THAT MEETS THE OUTER BRANCH OF THE PTERYGOID.

Exoccipital and opisthotic.—Both exoccipital bones are present, the left having the proötic of that side attached to it. The exoccipital contributes to the basal as well as forming all of the side boundary of the foramen magnum. The basal portion extends backward and forms the lateral portion of the occipital condyle. Articulated it would extend outward and backward as a flattened paraoccipital process having a vertically expanded, truncated end, which probably articulated with the supratemporal and quadrate as in *Varanus*. A foramen leads diagonally through this bone into the brain cavity, having its external exit ventral to the lower border of the paraoccipital process. Beneath and forward of this vagal foramen, a small, thin, winglike horizontal plate is developed which joins the lateral border of the basioccipital. In the comparatively limited development of this platelike process, with a decided notch between it and its junction with the paraoccipital process, it resembles the *Iguana* much more closely than *Varanus*, where this process extends outward on the lower side of the para-

occipital process for fully one-half its total length, while in *Saniwa* its extent would be less than one-fourth the total length. On the anterior side of the paraoccipital process, a sharp median longitudinal ridge divides the lower nonarticular from the upper articular surface with which it unites with the posterior branch of the proötic by squamous suture. On the inner anterior end a deep pit, a part of the auditory capsule, extends down into this bone. Immediately within the foramen magnum the exoccipital is perforated by a small foramen for the passage of the hypoglossal nerve, which makes its exit beneath the base of the lateral paraoccipital process.

FIG. 3.—RIGHT EXOCCIPITAL OF SANIWA ENSIDENS LEIDY. CAT. NO. 2185, U.S.N.M., TYPE. NATURAL SIZE. POSTERIOR VIEW.

In front of this foramen is a slitlike aperture, the internal auditory meatus, through which the auditory nerve leaves the cranial cavity and enters the external ear. In the crocodile the thin bone above and in front of this slitlike opening is the opisthotic, and from the close resemblance of this portion of the *Saniwa* brain case to that of the crocodile leads me to believe that the thin bone above the slit, forming a wall between the auditory capsule and the brain cavity, is the opisthotic, which, as in many other reptiles, has become united with the exoccipital early in life. Attached to the right exoccipital is a fragment of the rodlike columnella auditoris.

Supraoccipital.—The supraoccipital has a more pronounced median keel than in *Varanus*, and in this respect is intermediate between *Iguana* and *Varanus*. As in the latter genus, it forms the superior boundary of the foramen magnum. The upper end terminates obtusely, but is not so broad as in *Varanus*. Latterly it joins the exoccipitals; anteriorly the proötics and opisthotics, superiorly the parietal but by cartilagenous attachment only.

FIG. 4.—RIGHT EPIPTERYGOID OF SANIWA ENSIDENS LEIDY. TYPE. CAT. NO. 2185, U.S.N.M. NATURAL SIZE. POSTERIOR VIEW.

Epipterygoid.—The complete left epipterygoid and a portion of the right are present. It is a rounded bar with slight, but about equally expanded ends. The lower end is cut off obliquely, the upper is flattened on the inner side, where it laps against the forward extremity of the proötic. This bone has a total length of 16 mm.

Pterygoid.—The right pterygoid is present in its entirety, the left nearly as perfect. The latter was found in the matrix but little separated from its proper articulation with the ectopterygoid (see pl. 1) and palatine bones. The pterygoid in *Saniwa* is a long, slender, slightly curved bone, having a bifurcated anterior end and a flattened tapering posterior extremity which laps the inner distal side of the quadrate (see A, fig. 2). The slender rodlike posterior por-

tion is grooved on the dorsal and ventral sides by longitudinal sulci. On the dorsal surface forward of the center of the bone the development of a shallow pit marks the point of articulation with the epipterygoid. Anterior to this cuplike depression the bone rapidly widens, being terminated at the anterior extremity by two projecting articular processes, the larger inner process uniting with the palatine; the smaller outer process with the ectopterygoid. The thin notchlike border connecting these two processes forms much of the inner and all of the posterior boundaries of the infraorbital vacuity. The right pterygoid has a greatest length of 43 mm.; greatest width of anterior end, 10 mm.

The resemblance of this bone to the pterygoid of *Varanus salvator* (Cat. No. 29408, U.S.N.M.) is very close both in size, proportions, and method of articulation with surrounding elements, the only differences observed being the deeper longitudinal sulcus on the ventral side of the posterior half of the fossil bone and the higher and sharper ridges on both the ventral and dorsal sides of the border leading up to the process that meets the ectopterygoid bone. There is no evidence of pterygoid teeth.

Palatine.—Both palatine bones, but slightly displaced from their proper position in the palate, are shown in plate 1. Only their dorsal surfaces have been uncovered, but so far as they can be compared they appear very similar to the corresponding bones in the *Varanus* palate. The wide, flattened posterior end unites with the pterygoid. On the external side, near the middle of the bone, a heavy process extends outward to meet the posterior end of the maxilla. As in *Varanus*, this process is perforated by a longitudinal foramen, which leads into a cavity within the maxilla. A slender, pointed projection of this process extends backward along the maxilla, that, when articulated, probably met the ectopterygoid and entirely excluded the maxilla from participation in the formation of the boundary of the pterygoid or infraorbital aperture. Anteriorly the palatine sends forward a slender tapering process that laps the posterior end of the vomer on the inner side. The forward ends of the palatines are in contact on the median line, as shown in plate 1, but I am inclined to the belief that this has been brought about by transverse crushing and that originally they were separated, but probably not so wide apart as in the living *Varanus*. The character of the dorsal surface appears to indicate that it was in contact with the prefrontal and lachrymal bones as in *Varanus*.

Vomers.—The vomers are relatively wider transversely than in *Varanus* and they also differ in having a broader and deeper longitudinal depression on the dorsal surface. They appear to have been in contact on the median line throughout the greater part of their

length. Viewed from above, the outer border, which stands up as a vertical plate, curves in toward the median line and nearly if not quite meets the ridge on the vomer of the opposite side. From this point forward the outer border curves outward to meet the maxillary. The anterior ends of the vomers are missing in the type, as shown in plate 1.

FIG. 5.—LEFT LACHRYMAL OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. *A*, LATERAL VIEW; *B*, POSTERIOR VIEW.

Ectopterygoid.—Both ectopterygoid bones are present, but the right element is the more perfectly preserved. It is a curved bone, having a bifurcated posterior end that straddles the small outwardly turned process on the pterygoid, lapping above and below, thus forming a strong union of these two bones. Its curved and rounded inner border forms the greater part of the outer boundary of the infraorbital vacuity. The anterior end tapers out to an obtuse point having a groove on the external side that joined the posterior end of the maxillary. The anterior, outer border was in sutural contact with the jugal for half its entire length. Its greatest length over all is 16.5 mm.

Lachrymal.—The left lachrymal is almost perfectly preserved, lacking only a little of its external posterior border. Viewed from the side, it is a flat bone, subtriangular in outline, with a thickened posterior border that is slightly concave vertically. This end, which contributed to the boundary of the orbit, is perforated by two oval foramina, one above the other. The larger is above and separated from the lower one by a very narrow filament of bone. These appear to have a common exit on the median internal side of the bone. In *Varanus* the lachrymal is perforated by the usual lachrymal foramen, but the larger and more dorsal foramen of *Saniwa* is in the *Varanus*, represented by a notch, the inner border being formed by the lower branch of the prefrontal. A striated articular surface on the postero-inferior border appears to indicate the point of articulation with the forward end of the jugal as in *Varanus*. Its greatest length is 7.5 mm.; greatest height, 6.5 mm.

FIG. 6.—RIGHT MAXILLARY OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. LATERAL VIEW. *na*, BORDER THAT CONTRIBUTES TO THE BOUNDARY OF THE EXTERNAL NARIAL OPENING.

Maxillary.—Both maxillae retain their natural relationships to the interposed palatal bones as shown in plate 1. The right is the better preserved, though it lacks the anterior extremity and a portion of the median superior border. In so far as comparison can be made it closely resembles the maxillary of *Varanus*. The principal differ-

ence detected is that the lower posterior extremity of the fossil is more slender and tapering. It is pierced by a number of foramina that form a row slightly above, but parallel to the dental border. The sloping superior border anterior to where it joins the perfrontal forms the outer boundary of the anterior nares. This border turns inward toward the median line posterior to its anterior extremity, but the anterior portion of the bone is missing.

The right maxillary contains eight teeth and there are spaces for five more, making 13 teeth within a space 35 mm. long. The same space in *Varanus* contains only nine teeth. It is estimated that the missing portion would have carried two, possibly three more, so that in all the maxillary of *Saniwa* would have had at least 15 teeth, probably more. Because of the fragile nature of the bone and teeth no attempt has been made to free the internal or palatal side from the matrix. Posteriorly this bone certainly articulated with the palatine, ectopterygoid, prefrontal, and lachrymal, and probably also with the jugal.

Fig. 7.—Right postfrontal of Saniwa ensidens Leidy. Type, Cat. No. 2185, U.S.N.M. Natural size. Viewed from above. *p.f.*, cupped surface which articulates about equally with the lateral projections of the parietal and frontal.

Postfrontal.—The postfrontal is a moderate-sized trihedral bone, articulated by its expanded cranial end to the frontal and parietal by a cupped articular area between the divergent anterior and posterior branches (see *p.f.*, fig. 7), that fits in under and along the outer borders of these bones at their junction. On the posterior side of the pointed distal projection a roughened striated surface indicates the sutural contact of the postorbital, which in *Saniwa* exists as a distinct element. The left postfrontal and postorbital were found articulated (fig. 8), the suture distinctly shown, so that the manner of their articulation may be considered as absolutely determined. In all of the illustrations of the *Varanus* skull [3] and in three of the four skulls of this animal now before me the postfrontal-postorbital complex appears as a single bone. It is called postfrontal in all the illustrations of the *Varanus* skull, there being no mention made of the presence of a postorbital. However, on the ventral side of the right postfrontal of the skull *Varanus* (Cat. No. 29408, U.S.N.M.), the suture between it and the postorbital is visible under the glass. This suture takes essentially the same course as in the fossil specimen. Probably in a juvenile specimen the division between these two elements would be more clearly indicated. It is evident they coalesce early in life, so that in adult specimens all traces of the sutures are obliterated.

[3] Gadow, H. Amphibia and Reptilia, 1901, p. 542, fig. 138. Gadow recognizes these elements as the fused postorbital and postfrontal.

Postorbital.—Both postorbital bones are present, the left articulated with the postfrontal, the right detached. The latter has an expanded anterior end which articulates with the postfrontal by a cupped articular surface developed on the upper anterior border. In position it extends downward below the postfrontal as a pointed process (see fig. 8), but apparently not reaching the jugal. Extending posteriorly the postfrontal develops a slender tapering process which articulated with the squamosal, thus forming the supratemporal arcade as in other members of the Varanidae.

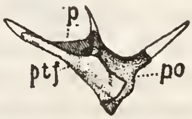

FIG. 8.—ARTICULATED LEFT POSTFRONTAL AND POSTORBITAL BONES OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. *p*, CUPPED BORDER FOR ARTICULATION WITH PARIETAL AND FRONTAL; *po*, POSTORBITAL; *ptf*, POSTFRONTAL.

Proötic.—The left proötic was found attached by matrix to the left exoccipital, but slightly displaced from its proper articulation with that element (see fig. 9). It closely resembles the corresponding bone in *Varanus salvator*, being a curved bone having a narrowed posterior half that laps along the upper anterior side of the paraoccipital process by squamous suture, and a flattened broader anterior half that turns upward from the horizontal at an angle of 45° to meet the parietal on the external side at about the middle of the supratemporal fossa. The inner posterior border forms a junction with the supraoccipital, exoccipital, and opisthotic. The inner surface of this flattened end contributes to the formation of the lateral wall of the brain cavity and to the boundary to the auditory capsule. The ventral process, which in *Varanus* extends forward and downward to articulate with the basiphenoid, is missing in the fossil, but presumably it will be found to be much like that of *Varanus*.

FIG. 9.—LEFT PROÖTIC ATTACHED TO EXOCCIPITAL OF SAME SIDE OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. LATERAL VIEW. *exo*, EXOCCIPITAL; *pro*, PROÖTIC.

Prefrontal.—The left prefrontal was found in the matrix but little disturbed from its proper articulation with the underlying bones of the palate. It is an irregularly shaped bone (see fig. 10) that forms the greater part of the anterior boundary of the orbit and contributes to both the dorsal and lateral surfaces of the skull. Internally it also develops a partial postlateral wall for the rhineocephalic chamber. The contribution to the dorsal surface is of considerably greater extent, both transversely and anteroposteriorly, than in a *Varanus* skull of equal dimensions. Posteriorly a tapering process extends backward along the outer edge of the frontal, which, as in *Varanus*, probably termi-

nated at about the center of the orbit. The anterior extension of this bone is missing. A decidedly roughened ridge is developed along the angle where it turns downward to form the lateral surface. This ridge probably marks the seat of attachment for the supra-orbital bone, which is missing in this specimen. On the ventral part of the lateral surface there is an indented articular area, which marks the point of articulation with the separate lachrymal bone. Posterior to the lachrymal articulation the bone turns inward, forming a wide contribution to the anterior border of the orbit. The ventral edge of this orbital portion is slightly expanded anteroposteriorly for articulation with the underlying palatine, to which it is joined in the articulated skull. Anteriorly it appears to have articulated with the maxillary as in *Varanus*. It probably was also in contact with the nasal, but of this I am not entirely certain.

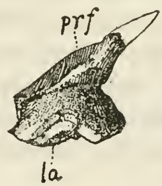

FIG. 10.—LEFT PREFRONTAL OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. *la*, SURFACE FOR ARTICULATION FOR LACHRYMAL; *prf*, FRONTAL BORDER.

Quadrate.—The complete left quadrate shows this element in its general characteristics to closely resemble the corresponding bone in the *Varanus* skull. It is a strong bone of moderate length, having a wide articular end for articulation of the lower mandible. This end has a transverse width of 8 mm. Viewed from the side, the quadrate is narrow anteroposteriorly at the lower end but rapidly widens in the same diameter toward the proximal end. This widening is brought about by the inner half of the bone being inclined strongly backward from the perpendicular. The upper articular end of the inner portion rises considerably above the upper extremity of the outer portion of the bone. In the articulated skull it is presumed that the inner articulated with the supratemporal, squamosal, and paraoccipitat bones as in *Varanus*. The outer half of the quadrate measures 15 mm. in length; the inner, 18 mm. On the inner side of the distal end a flattened facet evidently marks the place of contact with the posterior extremity of the pterygoid.

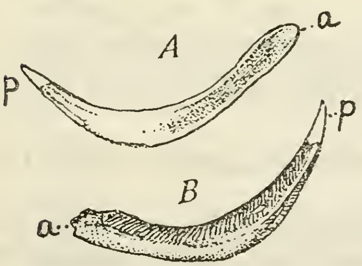

FIG. 11.—LEFT JUGAL OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. *A*, INTERNAL VIEW; *B*, EXTERNAL VIEW; *a*, ANTERIOR END; *p*, POSTERIOR END.

Jugal.—A long curved bone is provisionally identified as the left jugal. If this determination is correct it shows this bone to be considerably more robust than the jugal in a *Varanus* skull of equal dimensions (see fig. 1). The pointed posterior extremity is miss-

ing, but at the break it is triangular in section. On the ventral and internal sides of the anterior half of the bone it is longitudinally grooved for articulation with the ectopterygoid, maxillary, and palatine bones.

LOWER JAW.

Both rami of the lower mandible are fairly well preserved, except for the loss of the anterior halves of the dentaries. In their general proportions, relative extent of the various elements, and the manner of articulation of the component bones they closely resemble the rami of *Varanus*, the chief differences noted being the shorter but heavier expanded posterior extension back of the cotylus of the

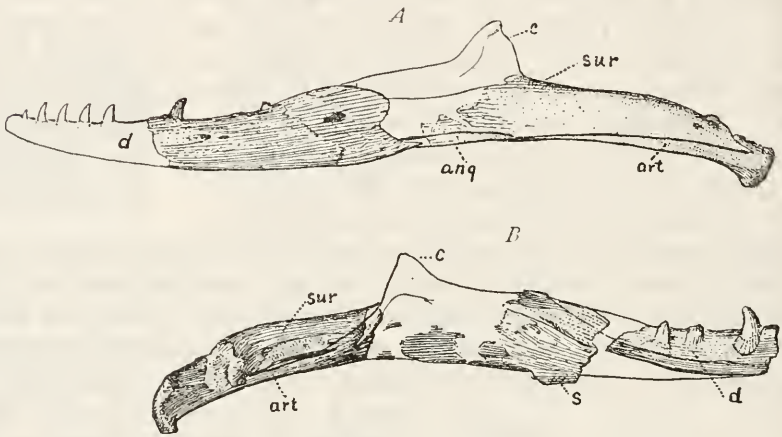

FIG. 12.—LEFT RAMUS OF SANIWA ENSIDENS LEIDY. TYPE, NO. 2185, U.S.N.M. NATURAL SIZE. A, EXTERNAL VIEW; B, INTERNAL VIEW; *ang*, ANGULAR; *art*, ARTICULAR; *C*, CORONOID; *d*, DENTARY; *s*, SPLENIAL; *sur*, SURANGULAR. ANTERIOR END OF DENTARY RESTORED FROM VARANUS.

ramus and the relatively narrower (vertically) posterior end of the dentary in *Saniwa*.

Dentary.—Viewed laterally the dentary joins the surangular by a nearly straight vertical suture at a point very slightly posterior of the center, as in *Varanus*. The union of these two bones, however, is not as weak as it would first appear, for the surangular extends forward on the inside of the dentary, thus forming an effective and strong articulation. Dorsally it meets the coronoid and ventrally the small angular, which sends forward a short process that is wedged in between the dentary and the splenial. The latter bone laps along the inner side of the dentary, covering the V-shaped mandibular fossa of that side.

Viewed from the side the dentary narrows toward the front. Near its posterior end the bone is perforated, as in *Varanus*, by a large oval foramina. Smaller perforations at intervals form a row immediately below and parallel to the dental border (see A, fig. 12).

The upper internal side of the dentary presents a beveled surface, on which the expanded bases of the pleurodont teeth are attached. This surface slopes downward from the outer alveolar border of the jaw, and gradually increases in width from the posterior end to the point where the bone is broken off.

Surangular.—The surangular is the largest bone of the posterior half of the ramus and forms the greater part of the external view of this portion of the jaw (see A, fig. 12). Posteriorly it has a pointed extremity which ends posterior to the cotylus of the jaw. Ventrally the posterior half of this bone unites by a horizontal suture with the underlying articular + prearticular, the anterior half with the smaller angular. The anterior end is truncated, this end passing 5 mm. inside the posterior end of the dentary. On the anterior, superior and upper lateral surfaces depressions of the bone distinctly marks the depth of overlap of the dentary. On the superior anterior border a grooved surface marks the seat of the coronoid bone which is detached. The posterior end of the surangular is trasversely expanded and contributes slightly to the formation of the anterior border of the cotylus for the articulation of the quadrate. On the inside of the jaw the surangular meets the prearticular by a horizontal suture somewhat below the middle of the ramus and continues forward to their contact with the overlying splenial.

Angular.—The angular is a small pointed bone that underlies the surangular externally and the forward extension of the prearticular internally (see A, fig. 12). As in the living Monitor, a slender pointed process continues forward, being intercalated between the splenial and dentary, slightly in advance of the vertical surangular-dentary suture. On the anterior internal side it is overlapped by a posterior projection of the splenial.

Articular+prearticular.—The so-called articular in the lizards is considered by Williston[4] to be the articular+prearticular complex. There is no indication of a suture in this specimen to show which part of this complex is articular and which is the prearticular portion. As a matter of convenience in describing this part of the ramus, that part of the complex lying in front of the cotylus will be arbitrarily considered the prearticular portion, and the posterior part, including the cotylus, the articular portion.

The articular + prearticular complex is an elongate bone that forms the whole of the lower boundary of the ramus posterior to the angular and all of the extension of the jaw behind, including the cotylus (see fig. 12). The prearticular portion extends forward beneath the surangular to meet the angular, where it passes from a lateral view, but internally it continues forward, the anterior end being intercalated between the splenial and dentary. Posteriorly it forms the

[4] Journ. of Geol., vol. 22, 1914, p. 411.

ventral margin of the posterior inframeckelian foramen. In front of this foramen in *Varanus* the prearticular is in contact with the coronoid and it is presumed that a similar condition would prevail in the completely articulated *Saniwa* ramus.

The articular portion of this ramus presents from a dorsal view a shallow concave, antero-posterior, but wide cotylus, behind which the articular is slightly contracted, the truncated end being enlarged, this latter expansion being especially pronounced in a ventral-internal direction. This posterior extension differs from *Varanus* in being shorter, relatively heavier, and in the development of a hooklike internal-ventral expansion of this end. The pointed posterior extremity of the surangular laps along the upper external side, ending about midway between the center of the cotylus and the posterior end of the ramus.

Splenial.—Although only the thin vertically expanded posterior portion of the left splenial is preserved (see B, fig. 12), an examination of the dentary along which this bone laps on the inner side shows that in shape and extent anteriorly it is approximately the same as in *Varanus.* It covers the inner side of the meckelian groove on the dentary and extends posteriorly, overlapping the anterior ends of the surangular, prearticular, and angular. It appears also to have been in contact with the coronoid.

Coronoid.—The right coronoid was found detached from the rest of the jaw and in a fair state of preservation. It is a small bone, curved from end to end, deeply grooved on the ventral side, which sets astride of the striated superior border of the surangular. The inner process that extends down to meet the prearticular is missing. Anteriorly when articulated it was in contact with the dentary and splenial as in *Varanus.*

TEETH.

The teeth of *Saniwa ensidens* are pleurodont. The right maxillary contains intact five of the six posterior teeth of the series in addition to two stumps more anterior, probably the ninth and tenth, counting from the back; the left maxillary contains the basal portions of four teeth; the left dentary two, and the right dentary has the three posterior teeth of the series, and the fifth from the back. Including three detached teeth found in the matrix, there are 20 teeth in all.

All of these teeth are sharply pointed, slightly curved backward, like the saber-shaped fangs of *Varanus.* The teeth are compressed from side to side, with trenchent borders fore and aft. The detached teeth as mentioned by Leidy are hollow, with thick walls.

As in *Varanus* the bases of the teeth are expanded, being anchylosed by the whole of their bases to the oblique surface of the bone which on the outside lead upward to slight depressions in the alveolar

borders. The base of the teeth are finely striated. The striations Owen[5] observes in *Varanus* are "produced by inflected folds of the external cement, as in *Ichthyosaurus* and *Labyrinthodon*, but they are short and straight as in the former genus."

The teeth throughout both upper and lower series are smaller than in a living *Varanus salvator* of the same size, and whereas there are 12 teeth in both the maxillae and dentaries of a *Varanus salvator*, in *Saniwa* there are not less than 14, probably more teeth in each series.

VERTEBRAE.

The vertebral column of *Saniwa* is represented by 33 fairly well-preserved vertebrae, with fragments of at least two more. Twenty of these may be classed as presacral, the remaining 13 as anterior caudal. The presacral vertebrae as now preserved are in three short series. The first, commencing with the complete atlas, consists of the first six of the column (see fig. 13) and a remnant of the centrum of the seventh, all articulated. The next block contains a series of four, there probably being one vertebra missing, of which only a fragment of the spine is preserved in the matrix. Although slightly disarranged, as shown in the matrix, plate 3, figure 2, it appears that those preserved were continuous in the series with those shown in plate 2, figure 2. Thus, the presacral series, with the possible exception of one centrum thought to be missing between blocks 1 and 2, form a continuous series from the skull back to the twenty-second vertebra. Since the living *Varanus* has 29 presacrals, it appears reasonable to suppose that *Saniwa* had an equal number in the complete series. Thus, there would be only seven vertebrae missing from the presacral series—one between the seventh and eighth, the remainder between the twenty-first and the sacrum. The caudal series is now preserved in three separate blocks of matrix, though probably all were originally joined, but the contacts have now been lost. There are 13 vertebrae in all of which the larger number, seven (see pl. 3, fig. 1), are so little disassociated as to show they were in series and probably form the anterior part of the tail.

Atlas.—The atlas is almost perfectly preserved and was but little disturbed from its proper relation with the axis. It consists of the strongly-keeled intercentrum, odontoid, and the two lateral neuropophyses, as shown in figure 13.

The centrum of the atlas (odontoid) is suturally united with the axis, and as in most reptiles its place is taken by the octogenous hypophyses or intercentrum. It presents a cupped articular surface for the basioccipital and a similar surface behind for the odontoid. The

[5] Owen, R. Anatomy of Vertebrates, 1866, vol. 1, p. 404.

base of each neurapophyses has an antero-internal articular surface that contributes to the formation of the cupped end for the reception of the occipital condyle, a middle surface for union with the neuropophyses, and a postero-internal surface for the upper and lateral parts of the odontoid. Above this articular end the neuropophyses is constricted fore and aft, above which it is widely expanded and arches over the neural canal, meeting on the median line without coalescing. There is no neural spine. Each neuropophyses develops from its upper and hinder border short zygapophyses which articulate with the axis. From its posterior side below a shorter diapophyses is developed.

The odontoid is wider than high and presents a convex face in front, which completes the articular cavity for the occipital condyle; below is the surface for the intercentrum, and above and behind it are the two articular surfaces for the neuropophyses. The whole pos-

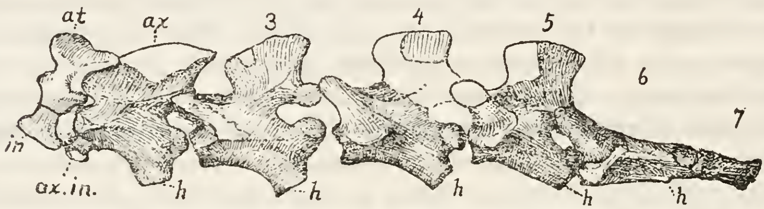

FIG. 13.—CERVICAL VERTEBRAE OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. *at*, ATLAS; *ax*, AXIS; *ax in*, AXIS INTERCENTRUM; *h*, HYPOPHYSES; *in*, INTERCENTRUM OF ATLAS; 3, 4, 5, 6, 7, CERVICALS THREE TO SEVEN, RESPECTIVELY.

terior part is sutured to the centrum of the axis and in part anchylosed to its hypophyses.

Axis.—The centrum of the axis measured nearly 15 mm. in length. Much of the spinous process is lacking. The forward part is thin and overhangs the odontoid. On the neural arch there is no trace of a diapophysis. On either side of the neural arch in front are articular surfaces representing the prezygapophyses, and on the posterior end the transversely expanded neural arch develops well-defined postzygapophyses. The centrum, as in all Varanids, terminates in a ball behind. Below this ball it sends downward and backward a heavy exogenous process with a cupped end which looks downward and backward for the articulation of the hypophysis which is missing. (See *h*, fig. 13.) This process is the heaviest of the series, whereas in *Varanus* they grow progressively heavier from the axis back to the sixth cervical.

Vertebrae posterior to the axis.—Articulated with the axis was the third, fourth, fifth, sixth, and anterior end of the centrum of the seventh vertrebrae, counting backward from the skull (see fig. 13). The vertebrae of *Saniwa* as compared with those of *Varanus*,

having a skull of equal size, are considerably smaller throughout the presacral series. The principal changes to be observed in the structure of the vertebrae between the third and seventh are: First, the development on the cervicals of forwardly projecting divergent anterior zygapophyses, which become longer and heavier in each succeeding vertebra back to the sixth of the series; second, the exogenous process for the hypophyses, which is largest on the axis, becomes rapidly reduced in size posteriorly, until on the sixth only a vestige[6] remains; third, the small parapophyses first developed on the third vertebra is decidedly larger on the fourth and increasingly so on each succeeding vertebra. It would appear that the fourth, fifth, and sixth vertebra bore short ribs as in *Hatteria*, whereas in *Varanus salvator* the seventh is the first to have a cervical rib; in *Sauromalus* the first rib is on the fourth cervical.

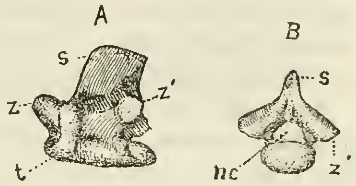

FIG. 14.—DORSAL VERTEBRA OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. A VIEWED FROM LEFT SIDE; B VIEWED FROM POSTERIOR END; *nc*, NEURAL CANAL; *s*, SPINOUS PROCESS; *t*, TRANSVERSE PROCESS; *z*, ANTERIOR ZYGAPOPHYSIS; *z'*, POSTERIOR ZYGAPOPHYSIS.

The centra in this series are approximately the same length throughout, with a cup in front and ball behind, a feature common to most lizards, and which continues throughout the vertebral column.

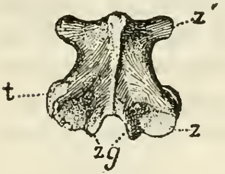

FIG. 15.—DORSAL VERTEBRA OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U. S. N. M. NATURAL SIZE. SUPERIOR VIEW. *t*, TRANSVERSE PROCESS; *z*, ANTERIOR ZYGAPOPHYSIS; *z'*, POSTERIOR ZYGAPOPHYSIS; *zg*, ZYGANTRA.

The neural spines of the cervical series in *Saniwa* are badly damaged, but they do not appear to have been taller than in the succeeding dorsals, whereas in *Varanus* they are higher, and wider fore and aft, than any that follow them in the presacral series. These spines are thin transversely, but wide (anteroposteriorly) plates of bone that terminate dorsally with truncated extremities without transverse expansion. The posterior zygapophyses do not protrude beyond the ball of the centrum.

The second series of four articulated vertebrae (see pl. 2, fig. 2) are thought to represent the eighth, ninth, tenth, and eleventh of the vertebral series enumerated from the skull. These exhibit a flattened ventral surface of the centra so typical of all the members of the family Varanidae. The nonarticular surfaces of the centra are slightly shorter than in the preceding series, as may be seen by referring to the table of measurements.

[6] In this feature *Saniwa* resembles *Varanus griseus*, where the hypophyses end with the sixth cervical, there being only a slight elevation on the seventh, while in *V. salvator* hypophyses extend back to the seventh and sometimes a vestige is found on the eighth.

The articular ball of the centrum in all the succeeding vertebrae available for measurement are nearly twice as wide as high, the articular surface being inclined upward and backward. The diapophyses extending outward from the anterior side of the centra gradually grow more robust, proceeding posteriorly. The anterior zygapophyses also become successively shortened, but with broader articular faces. The spinous processes remain about the same height as in the preceding series, but appear broader antero-posteriorly.

The third series of articulated dorsals, consisting of 10 vertebrae, probably represent the twelfth to the twenty-first. (See pl. 3, fig. 2.) All resemble one another so closely that a description of one will do for all. Except for their relatively shorter spines and smaller size, I am unable to find any other features that would distinguish them from the corresponding vertebrae in the skeleton of *Varanus salvator*, from Java (Cat. No. 29551, U.S.N.M.) now before me.

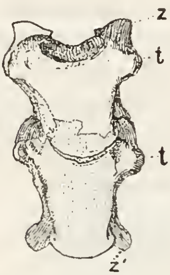

FIG. 16.—DORSAL VERTEBRA OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. *t*, TRANSVERSE PROCESSES; *z*, ANTERIOR ZYGAPOPHYSIS; *z'*, POSTERIOR ZYGAPOPHYSIS.

The anterior articular concavity of the centrum is a transverse ellipse, obliquely placed, looking downward and forward, the under surface of the body being flattened anteroposteriorly and slightly convex transversely. The articular convexity corresponds in size and shape with the anterior cup, with an opposite aspect, looking upward and backward at an angle of 45° to the lower surface of the centrum (see fig. 16). The lateral margins of the ball project a little beyond the narrow constriction which divides it from the rest of the centrum.

In advance of this constriction the sides of the body rise, expanding outwardly at the anterior end to form the projecting costal tubercle, which appears to be supported by both the neurapophyses and centrum, though nowhere in the series is there a trace of the neurocentral suture to be found. The tubercle for the ribs in this section of the column presents a hemispherical articular surface as in the living Monitor. In front of the tubercle the heavy support of the prezygapophyes rises, extending upward and slightly forward, the upper articular surface being flat looks inward and upward, the whole projecting but slightly anterior to the forward end of the centrum.

The upper surface of the broad neural arch between the anterior zygapophyses is, roughly speaking, concave, but traversed longitudinally by a median elevation that develops on its anterior margin,

two flattened forwardly projecting processes between which on the median line is a broad notch. I regard these processes as rudimentary zygosphenes (see *zg*, fig. 15). Marsh[7] notes a similar articulation on the dorsal vertebrae of *Thinosaurus paucidens*. The absence of zygantry, however, shows that they no longer function as a true zygosphene-zygantrum articulation. The posterior half of the upper surfaces of the neural arch is convex and expands outward at its back part to form the posterior zygapophyses (see fig. 14, B), the articular surface of which looks downward and outward. The median part of the arch develops a wide (anteroposterior) spine of moderate height. This spine is very thin, but thickens posteriorly, especially its posterior upper extremity. The posterior part of the arch, including the zygapophyses, overhangs the centrum, but terminates forward of its most posterior extension.

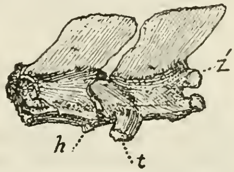

FIG. 17.—ANTERIOR CAUDAL VERTEBRAE OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. VIEWED FROM LEFT SIDE. *h*, HYPOPHYSIS FOR ARTICULATION OF CHEVRON; *t*, TRANSVERSE PROCESS; *z'*, POSTERIOR ZYGAPOPHYSIS.

Caudal vertebrae.—There are 13 caudal vertebrae present, all apparently from the proximal fourth of the tail. These are in three blocks of matrix, of which the better-preserved vertebrae, four in number, remain articulated (see pl. 3, fig. 1). These, however, indicate one important difference when compared with the tail of *Varanus* and that is the low, broad, spinous processes of the presacral region continue back much further in the caudal series. Though they do gradually increase in height posteriorly, it appears very doubtful if they ever attained the great height found in the living Monitor, *Varanus salvator* (see fig. 17). Nor do any of the 13 vertebrae indicate a fore-and-aft narrowing of this process such as begins to take place in the third vertebra back of the sacrum in *Varanus*. The caudal centra are more elongate than in the mid dorsal region; the middle ventral surface is traversed longitudinally by a shallow depression. They retain the cup-and-ball articulation found in the presacral series. On the posterior third of the ventral surface of the centrum a pair of short articular protuberances indicate the point of attachment for the chevron (see fig. 18).

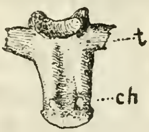

FIG. 18.—ANTERIOR CAUDAL VERTEBRA OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185. U. S. N. M. NATURAL SIZE. VENTRAL VIEW. *ch*, HYPOPHYSIS FOR CHEVRON; *t*, TRANSVERSE PROCESS.

The apparent absence of caudal vertebrae, having high spinous processes, suggests that *Saniwa* was a terrestrial form having a

[7] Amer. Journ. Sci., ser. 3, vol. 3, 1872, p. 299.

rounded rather than a transversely flattened tail. The dissection of a specimen of *Varanus griseus* from Egypt, a strictly terrestrial form shows that the spinous processes do not increase so rapidly in height from the sacrum backward as in *V. salvator.*

Measurements of vertebrae of Saniwa ensidens, No. 2185, U.S.N.M.

Position of vertebrae in presacral series.	Axis.	Third.	Fifth.	Eleventh.	Twelfth	Eighteenth.	Nineteenth.	Caudal.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Length of nonarticular lower surface of centrum..	13	13	13	10.5	10.5	11	......	13
Breadth of centrum forward of ball..................	4.5	......	......	7	7.5	7.5	......	6
Breadth of neural arch across diapophyses............	8	11	......	16	17	16	......	17
Vertical diameter of ball of centrum................	......	......	......	4	4.5	......	......	4
Transverse diameter of ball of centrum..............	......	......	......	7.5	8	8	......	7
Greatest vertical diameter of vertebræ..............	......	20	17	15.5	......	......	15	17

GIRDLE AND LIMB BONES.

Coracoid.—The scapular arch is represented only by the right coracoid which lay in the matrix at the proximal end of the humerus of that side and opposite the ninth and tenth vertebrae of the series, as shown in plate 2, figure 2. Only the ventral side has been exposed. It is a broadly expanded bone having a single deep notch on the anterior border as contrasted with the two deep notches in the *Varanus* coracoid. Between the posterior border of this notch and the glenoid border the bone is perforated by a large coracoid foramen. The pointed posterior projection is more slender than in *Varanus.* (Compare figs. 19 and 20.) The precoracoidal process has suffered the loss of its articular end, as has the anterior extremity of the coracoid internal to the notch.

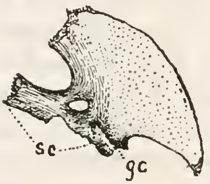

FIG. 19.—LEFT CORACOID OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. NATURAL SIZE. VENTRAL VIEW. *gc*, CORACOID CONTRIBUTION TO THE FORMATION OF GLENOID FOSSA; *sc*, BORDER THAT ARTICULATES WITH SCAPULA.

The presence of a single notch and the long sweeping convex curve of its inner border, this bone resembles the coracoid of *Loemanctus longipes*, as figured by Parker.[8] The bone is much thickened dorsoventrally at the border of the glenoid cavity. The ventral surface is slightly convex antero-posteriorly as in the Monitor. The coracoid measures 15 mm. in width from the glenoid border to the inner edge. As preserved it measures 17 mm. antero-posteriorly. The notch at its widest expanse measures 6 mm. across.

[8] Reynolds, S. H. The Vertebrate Skeleton, 1897, p. 286, fig. 54.

Humerus.—The right humerus is present and in a fair state of preservation. Some portions of the anterior side of the distal half of the shaft and the condylar articular surface for the radius on the distal end are missing. Compared with the corresponding element in a skeleton of *Varanus salvator*, No. 29551, U.S.N.M., it agrees very closely in general form except for the more abrupt expansion of the ulnar side of the distal end and the apparent reduction in extent of the thin sharp ridge on the radial or outer border. This ridge is perforated by the ectepicondylar foramen. The ridge appears to have been restricted in height and also in the distance it extended upward on the shaft of the bone, as contrasted with the *Varanus* humerus (see fig. 21). In the abrupt outward expansion of the ulnar border of the distal end, this bone more nearly resembles the humerus of *Iguana tuber-*

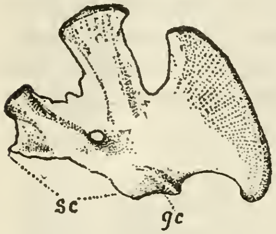

FIG. 20.—LEFT CORACOID OF VARANUS SALVATOR. CAT. NO. 29551, U.S.N.M. VENTRAL VIEW. NATURAL SIZE. COMPARE WITH FIG 19 *gc*, GLENOID CAVITY; *sc*, SCAPULA ARTICULATION.

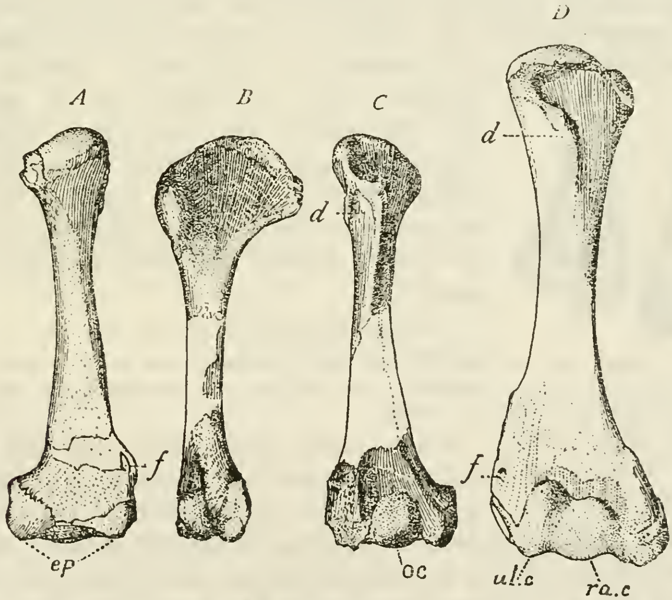

FIG. 21.—LEFT HUMERUS OF SANIWA ENSIDENS LEIDY. TYPE, CAT. NO. 2185, U.S.N.M. A, SUPERIOR VIEW; B, OBLIQUE INFERIOR VIEW; C, VENTRAL VIEW; D, LEFT HUMERUS OF VARANUS SALVATOR. CAT, NO. 29551, U.S.N.M. VENTRAL VIEW. *d*, DELTOID CREST; *ep*, EPIPHYSIS; *f*, FORAMEN; *oc*, OUTER CONDYLE; *ra.c*, RADIAL CONDYLE; *ul.c*, ULNAR CONDYLE. ALL NATURAL SIZE.

culata. In *Varanus* the same expansion is achieved, but by a gradual curve outward, beginning higher up on the shaft of the bone. *Varanus sivalensis*, as figured[9] by Falconer, is intermediate in respect to the contour of this end of the humerus.

[9] Paleontological Memoirs, vol. 1, 1888, pl. 32.

The shaft is nearly straight and subcylindrical, as in most other Lacertilians, with a large medullary cavity. The transversely expanded distal end has two condyles; the one for articulation with the radius, however, is missing in this specimen. The proximal articular head is transversely elongated, being suboval in outline. The radial crest projects from the shaft at some distance below the head of the bone.

Comparative measurements of humeri.

	Saniwa ensidens, 2185, U.S.N.M.	*Varanus salvator*, 25551, U.S.N.M.
	mm.	*mm.*
Greatest length	54	68
Greatest width, proximal end	19	24.5
Greatest width, distal end	17.5	23
Least diameter of shaft	5	6

The distal end of the humerus figured[10] by Leidy as pertaining to *Saniwa major* is so entirely different in its principal characteristics, when compared with the humerus of either *Saniwa ensidens* or *Varanus salvator*, as to indicate at once that it pertains to a different type of animal. It is certainly not referable to the Varanidae. Since the above comment was written, Fejérváry's excellent paper[11] on the Fossil Varanidae has come to hand, and I find that he had previously reached the same conclusion. He says:

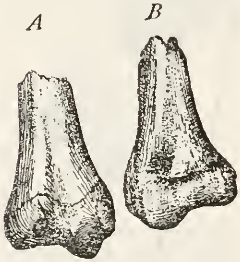

Fig. 22.—Distal end of right femur of Saniwa ensidens Leidy. Type, Cat. No. 2185, U.S.N.M. Natural size. A, superior view; B, ventral view.

> The humerus described (p. 182) and figured (pl. and fig. 14) by Leidy as belonging to *S. major* is undoubtedly not reptilian and therefore can not belong to *Saniwa*.

Femur.—The distal end of the left femur and the proximal half of the tibia of the same side is all that is preserved of the posterior limb of the type specimen. Excepting its slightly smaller size and the lesser prominence of the ridge developed on the internal-anterior side and which continues down on to the distal end, this portion of the femur is very similar to the corresponding bone in the *Veranus* skeleton. The principal features of the distal portion of the femur are well shown in figure 22. The articular surface, which is well toward the posterior side, is broadly concave transversely. On the anterior side external to the center of the bone is a well-defined

[10] Leidy, J. Rept. U. S. Geol. Survey of Terr. F. V. Hayden, U. S. Geologist in charge, vol. 1, 1873, pl. 15, fig. 14, p. 182.

[11] Ann. Mus. Nat. Hung., vol. 16, 1918, p. 421.

groove which extends for a short distance up on the shaft of the bone. The epiphysis of the distal end of this bone is as distinctly defined as in the living *Varanus*. The broken end of the shaft shows a large medullary cavity, now filled with calcite. The transverse diameter measures 13.2 mm.; the fore and aft diameter at the center is 8.5 mm.

Tibia.—The proximal half of the left tibia (see pl. 2, fig. 2) shows the same broad expansion of the upper end with flattened anterior surface, and the same contracted subtriangular shaft at the middle with large medullary cavity as in the living Monitor. In fact, I fail to find any characters by which it may be distinguished from *Varanus*. The proximal end of the tibia has a greatest transverse width of 13 mm.

Ribs.—In the three blocks of matrix containing the presacral vertebrae there are parts of more than 18 ribs (see pl. 3, fig. 2), several being nearly complete. All of the ribs appear to be single headed. A rib lying in the matrix near the right coracoid has a vertically expanded head, indicating that it probably pertains to the posterior cervical series, the expansion of the head corresponding to the elongation of the parapophyses in this region of the neck. The thoracic ribs, however, do not have any appreciable enlargement of the proximal end, which is cupped for articulation with the hemispherical parapophyses of the dorsal vertebrae. The proximal half of the larger thoracic ribs is flattened both fore and aft, becoming subcylindrical as the distal end is approached, which is slightly expanded. These ribs, in fact, all of the ribs, appear to be moderately but regularly curved from end to end.

DISCUSSION OF THE FAMILY, AND GENETIC RELATIONSHIPS OF THE GENUS SANIWA.

Family VARANIDAE.

Postorbital bar incomplete; temporal arcade complete; supratemporal fossa not roofed over by dermal bones; single premaxillary bone; nasals coalesced and narrow; infraorbital vacuity bounded by the pterygoid, palatine, and ectopterygoid, the maxillary being excluded; palate toothless; hameal surfaces of the dorsal vertebrae broad, flat, and devoid of carina;: vertebrae usually without zygosphene or zygantrum, when present a vestigal zygosphene only. No dermal ossifications.

In the characterization of the family Varanidae as given above I have selected from the definitions of Lydekker,[12] Boulenger,[13] and Fejérváry[14] such parts of their family characterizations as

[12] Catalogue of Fossil Reptilia and Amphibia in British Museum, pl. 1, 1888. p. 281.
[13] Fauna Brit. India, Rept. and Batr., London, 1890, pp. 160–161.
[14] Ann. Mus. Nat. Hung., vol. 16, 1918, p. 365.

relate to the bony structure, thus making the definition applicable to the fossil members of the family, and add remarks of my own on the presence of a vestigal zygosphene.

The Varanidae or Monitors form a group comprising both recent and fossil representatives. In 1918 Fejérváry[15] listed 43 forms as being referable to the family Varanidae. Forty-one of these pertain to the genus *Varanus* and two to the genus *Saniwa;* the latter, although included under the Varanidae, was regarded by him of "Uncertain systematical position."

His more extended remarks[16] are quoted in their entirety below:

> It must be here remarked that the genus *Saniva* described by Leidy and originating from the Eocene of Wyoming, in America, is also held by Nopcsa as a Varanid, and taking this supposition for granted, the *Neartis* should also be involved in the history of the evolution of the *Varanidae.* However, Lydekker, Zittel (op. cit.), as well as Broili (1911) (op. cit., p. 216) range this problematical genus with the *Anguidae,* so that, according to their opinion, it would not even be related to the *Platynota* but to the suborder of *Lacertilia vera* (= *Kionocrania*). After a conscientious perusal of Leidy's descriptions and drawings, I am obliged to confess to the genus *Saniva* yet appearing a complete mystery to me. Neither the description nor the drawings throw sufficient light on even the most important characters. The humerus, for instance, presents a particularly birdlike appearance, as Leidy himself very judicially remarks. The vertebrae, on the other hand, do, indeed, resemble those of *Varanus,* although the figures allow no perspective as to the shape of the dorsal surface. It must be taken into consideration, however, that the vertebrae of an *Anguidae* and *Varanidae* in many respects bear great likeness to each other, for which reason the resemblance with *Varanus* can not be judged as a decisive phenomenon. Moreover, it does not seem impossible that the vertebrae will ultimately prove to belong to *Varanidae* and will thus have to be separated from at least a part of the remains left.

The observation recorded above is a very logical and concise summary of the status of the genus *Saniwa*, based on the scanty information then available (1918) to Fejérváry.

The more recent preparation of the type materials, however, now shows the genus *Saniwa* to be based on an adequate specimen, and it thus removes some of the uncertainties of which Fejérváry justly makes mention.

The incompleteness of the postorbital bar; the toothless palate; pterygoids and palatines, widely separated; infraorbital fossa bounded by pterygoid, palatine, and transverse, the maxillary being excluded; pleurodont dentition; teeth pointed; dorsal centra with flattened haemal surfaces devoid of carina; and the absence of dermal scutes constitute a combination of characters, together with the close resemblance of most of the bones of the skeleton to the living

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[15] Ann. Mus. Nat. Hung., vol. 16, 1918, pp. 444–445. [16] Idem, pp. 362–363.

genus *Varanus*, indicating *Saniwa* to be a true member of the family Varanidae.

Although Leidy studied only a few of the bones of the type specimen, he more than any subsequent authority correctly diagnosed its true relationships. He says:[17]

The remains belong to a lacertain about the size of the existing monitor of the Nile, to which it appears to be closely related. The bones indicate a robust body, a long tail, and limbs with long toes.

The vertebrae resemble those of the Nilotic monitor in form and proportions, and like them possesses no zygosphenal articulation.

The last statement is now known to be incorrect as there are vestigal zygosphenes present on the dorsal vertebrae, but I do not consider their presence of sufficient morphological importance to bar the assignment of *Saniwa* from the Varanidae, especially since they appear to be undergoing reduction, thus tending toward the conditions found in the *Varanus* vertebrae, where they have entirely disappeared. It was the discovery of similar reduced zygosphenal articulations of the vertebrae that led Marsh[18] in 1872 to establish the genus *Thinosaurus*, which he recognized as being closely related but distinct from *Saniwa* because of the supposed absence of zygosphenes in that genus. A careful study of Marsh's description and measurements of the genotype *Thinosaurus paucidens* leads me to the conclusion that *Thinosaurus* and *Saniwa* are congeneric. The latter being the older by two years, *Thinosaurus* thus becomes a synonym, and the described species will hereafter be designated respectively *Saniwa paucidens* (Marsh), *S. leptodus* (Marsh), *S. crassus* (Marsh), *S. grandis* (Marsh), and *S. agilis* (Marsh).

It would also appear quite probable that a comparative study of the type specimens on which the above species were founded would show one or more of them to be referable to *Saniwa ensidens* Leidy.

Tinosaurus, which Fejérváry[19] regards as being equivalent of *Thinosaurus*, probably represents a distinct genus, as is apparently indicated by Marsh's meager description,[20] in which the teeth are described as having cusps, whereas all of the known Varanidae have simple coned teeth without auxilliary cusps.

The family Varanidae therefore contains the genus *Varanus*, largely made up of living species of lizards, and the genus *Saniwa*, which at this time includes six or more extinct species.

[17] Leidy, J. Rept. U. S. Geol. Survey Terr., F. V. Hayden, U. S. in charge, vol. 1, 1873, p. 181.

[18] Marsh, O. C. Amer. Journ. Sci., vol. 4, 1872, pp. 299–300.

[19] Ann. Mus. Nat. Hung., vol. 16, 1918, p. 362.

[20] Amer. Journ. Sci., ser. 3, vol. 4, 1872, p. 304.

The distinctness of the two Varanid genera *Varanus* and *Saniwa* is clearly set forth by the enumeration of their more important characters as contrasted in the two paralled columns below:

Genus *Varanus*.	Genus *Saniwa*.
1. Dorsal vertebrae without zygospheneal articulations.	1. Dorsal vertebrae having vestigal zygosphene articulations.
2. Coracoid having two anterior notches.	2. Coracoid having a single anterior notch.
3. Postorbital usually fused with postfrontal.	3. Postorbital distinct from postfrontal.
4. Hypophyses on first six or seven cervical vertebrae, vestigal on the seventh or eighth.	4. Hypophyses on first five cervical vertebrae, vestigal on the sixth.
5. First rib carried on the seventh cervical.	5. First rib appears to have been carried on the fifth cervical, possibly the fourth.
6. Humerus with gradually expanded ulnar border at distal end.	6. Humerus with abruptly expanded ulnar border at distal end.

A critical comparison of *Saniwa*, especially with the existing members of the family, appears to show a few of the evolutionary changes undergone by the Varanid skeleton since Middle Eocene times. These are: 1. the loss of the vestigal zygosphene; 2, a reduction in the number of teeth in the jaws; 3, the complete coalescence (usually) of the postfrontal postorbital bones; and 4, an increase in the number of cervical vertebrae bearing hypophyses.

The living members of Varanidae, Monitors as they are often called, form a group of about 30 species, all belonging to the one genus *Varanus*. Living members of this genus inhabit the tropical parts of Africa, Southern Asia, Malasia, and Australia. All are carnivorous in habit, feeding upon small backboned animals, insects, and especially upon eggs, which they crush between their teeth while holding them aloft. Most species live wholly upon the land and some are arboreal. Others, especially those found along the Nile, live about water and are excellent swimmers. The terrestrial species are said[21] to have "a round tail and small external nostrils, but the water species have the tail much flattened and the nostrils have large cavities."

Most of the species live wholly upon the land. *V. prasinus* is supposed to be arboreal. Others, as *V. salvator* and *V. niloticus*, owing to the fact of their tail being strongly compressed, are excellent swimmers and deserve the name of water lizards. The terrestrial species, as *V. griseus*, have rounded tails. The apparent absence of caudal vertebrae having high spinous processes suggest that *Saniwa* was also a terrestrial species, having a rounded rather than a flattened tail.

[21] Williston, S. W. Water Reptiles of the Past and Present, 1914, pp. 144–145.

The extinct members of the genus *Varanus* have been thoroughly reviewed and discussed in Fejérváry's excellent paper, Contributions to a Monography on Fossil Varanidae and on Megalanidae, and, as he has so clearly pointed out, are very unsatisfactorily known. Of the 10 extinct species described, he regards only four of "established specific value." At this time very little satisfaction was obtained in attempting to contrast the extinct American forms with the European species, except that *Saniwa* from the Bridger (Middle Eocene) has the distinction of being the most ancient Varanid lizard yet discovered in North America, if not in the world.

List of North American fossil Varanidae.

Names.	Locality.	Formation.
Saniwa ensidens Leidy.....	Near Granger, Wyoming....	Bridger, Middle Eocene.
Saniwa major Leidy........	Lodge Pole Trail crossing, Dry Creek, Wyoming.	Do.
Saniwa paucidens (Marsh)..	Grizzly Buttes, Wyoming...	Do.
Saniwa leptodus (Marsh).....	.....do......................	Do.
Saniwa crassus (Marsh).....	Henry's Fork, Wyoming....	Do.
Saniwa grandis (Marsh).....	Grizzly Buttes, Wyoming...	Do.
Saniwa agilis (Marsh)......	Henry's Fork, Wyoming....	Do.

EXPLANATION OF PLATES.

Plate 1.

Palate of *Saniwa ensidens* Leidy. Cat. No. 2185, U.S.N.M. Type. Twice natural size. Viewed from above. Shown as found articulated in the matrix. *mx*, maxillaries; *pl*, palatines; *pt*, pterygoids; *v*. vomers.

Plate 2.

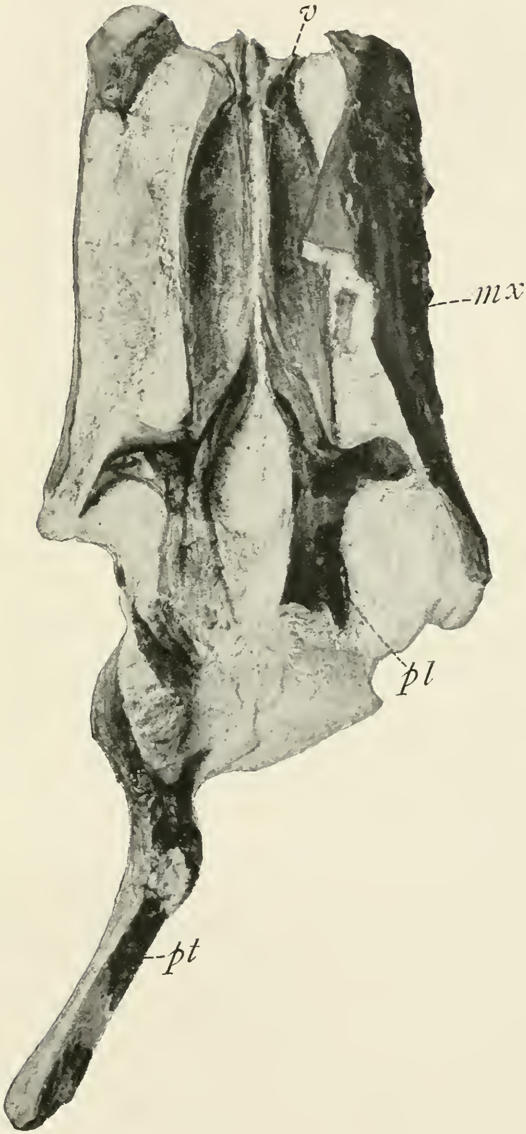
Fig. 1. Cervical vertebrae *of Saniwa ensidens* Leidy. Cat. No. 2185, U.S.N.M. Type. Natural size. Viewed from the left side. Shown as found articulated except that the atlas has been removed.

Fig. 2. Dorsal vertebrae and other bones of *Saniwa ensidens* Leidy. Cat. No. 2185, U.S.N.M. Type. About natural size. Shown as found in the matrix. *a*, four anterior dorsal vertebrae, ventral view; *b*, left coracoid; *c*, right humerus; *d*, distal end of femur; *e*, proximal half of tibia.

Plate 3.

Fig. 1. Caudal vertebrae of *Saniwa ensidens* Leidy. Cat. No. 2185, U.S.N.M. Type. About natural size. Shown as found in the matrix.

Fig. 2.—Dorsal vertebrae and ribs of *Saniwa ensidens* Leidy. Cat. No. 2185, U. S. N. M. Type. About natural size. The two vertebrae on the right with ventral surfaces exposed are the ones figured by Leidy. *a*, distal end of humerus.



PALATE OF SANIWA ENSIDENS.

FOR DESCRIPTION OF PLATE SEE PAGE 28.

VERTEBRAE AND LIMB BONES OF SANIWA ENSIDENS.

FOR DESCRIPTION OF PLATE SEE PAGE 28.

VERTEBRAE AND RIBS OF SANIWA ENSIDENS.

FOR DESCRIPTION OF PLATE SEE PAGE 28.

TERRESTRIAL ISOPODA COLLECTED IN JAVA BY DR. EDWARD JACOBSON WITH DESCRIPTIONS OF FIVE NEW SPECIES.

By Harriet Richardson Searle,
Collaborator, Division of Marine Invertebrates, United States National Museum.

The following is a report on a collection of terrestrial isopods sent to me by Dr. Edward Jacobson. The specimens are all from the island of Java, and were taken during the years 1909 to 1911. They represent several new species, as well as a number of described species.

The new species are: *Cubaris insularis*, *Toradjia dollfusi*, *Philoscia jacobsoni*, *Philoscia javanensis*, and *Philoscia buddelundi*.

Among the known species, *Cubaris murina* Brandt has previously been recorded by Dollfus from Java and was noted by Budde-Lund in an unpublished list of terrestrial Isopods from Java, which is given below. *Porcellio sundaicus* and *Porcellio modestus* were described by Dollfus in his report on the Isopods from the Dutch East Indies.

The altitude of the collecting localities is as follows: Semarang, 55 meters; Nusa Kambangan, 50 meters; Djocja, 113 meters; Nongkodjadjar, 1,200 meters; Gunung Gedeh, 1,200 to 1,400 meters.

Dr. E. Jacobson requested me to mention in this paper that a small collection of Isopoda had formerly been sent by him to the late Dr. G. Budde-Lund (Copenhagen), who left a report on this collection which was, however, not published.

The collection contained the following species:

Cubaris murina Brandt, Krakatau, May, 1908, and Bataira, January, 1909.

Nagara cristata (Dollfus), Krakatau, May, 1908.

Nagara nana Budde-Lund, Semarang, December, 1909.

Alloniscus brevis Budde-Lund, Krakatau, May, 1908.

Setaphora weberi Dollfus, Semarang, December, 1909; Batavia, January, 1909.

Kisuma papillosa Budde-Lund, new species.[1]

This collection is now in the British Museum but I have not as yet had an opportunity of examining it.

[1] This species was published in, Notes from the Leyden Museum, vol. 34, 1912, pp. 169-170, pl. 8.

It is interesting to note that *Cubaris murina* (Brandt) is the only species found in both collections, the earlier one sent to Budde-Lund and the later collection sent to me, of which this is the report.

Although most of the species in the earlier collection identified by Budde-Lund are known species, some of them had not yet been recorded from Java. The locality Krakatau is certainly new, as this island got a new fauna after the eruption of 1883.

Genus CUBARIS Brandt.

CUBARIS MURINA Brandt.

Cubaris murina BRANDT, Bull. Soc. Imp. Nat. Moscou, vol. 6, 1833, p. 28.

Cubaris brunnea BRANDT, Bull. Soc. Imp. Nat. Moscou, vol. 6, 1833, p. 28.

Armadillo murinus MILNE EDWARDS, Hist. Nat. des Crust., vol. 3, 1840, p. 179.

Armadillo brunneus MILNE EDWARDS, Hist. Nat. des Crust., vol. 3, 1840, p. 179.

Armadillo conglobator BUDDE-LUND, Prosp. generum specierumque Crust. Isop. Terrestrium, 1879, p. 7.

Armadillo murinus BUDDE-LUND, Prosp. generum specierumque Crust. Isop. Terrestrium, 1879, p. 7; Crust. Isop. Terrestria, 1885, pp. 27–28.—DOLLFUS, Zool. Ergebnisse einer Reise in Niederländisch Ost-Indien, vol. 4, Heft 2, 1907, p. 359.

Locality.—Semarang, Java; 1 specimen.

CUBARIS INSULARIS, new species.

Plate 1, fig. 1.

Body ovate, surface smooth. Color in alcohol yellow, with reddish brown dots, forming a double irregular median band and a band on either side of the body, within the lateral parts of the segments. A few of these dots are scattered over the light areas of the body.

The head is much wider than long, with the eyes small and composed of a few ocelli situated in the post-lateral angles. The anterolateral lobes are small and the front straight. The second pair of antennae have the flagellum composed of two articles, the second of which is about three times as long as the first.

The first segment of the thorax is about twice as long in the median line as any of the following, which are subequal. The coxopodite is represented by a small notch at the posterior extremity of the segment; it is not distinct or divergent from the segment. The second thoracic segment has a distinct coxopodite on the anterior half of the underside of the segment, represented by a small lobe near the lateral margin.

The first two segments of the abdomen have the lateral parts covered by the last thoracic segment. The following segments continue the oval outline of the body. Terminal abdominal segment about one and a half times wider at the base than at the extremity, with the sides excavate and the extremity roundly truncate. The basal article of the uropoda reaches the extremity of the terminal

abdominal segment, and is just a little longer than wide. The inner branch is not visible in a dorsal view, as it extends only about three-quarters of the length of the segment. The outer branch is small and is inserted about the middle of the inner lateral margin of the basal article (in a dorsal view).

Eleven specimens come from Nongkodjadjar, Java, and one specimen is from Nusa Kambangan, Java.

This species is close to *Cubaris rectifrons* (Dollfus), but differs from it in the form of the coxopodites of the first thoracic segment, which are represented only by a notch at the post-lateral angle of the segment, while in *C. rectifrons*, they are distinctly separated on the posterior quarter of the segment and neatly divergent. The inner branches of the uropoda are also slightly longer in the new species and the outer branch situated not at the extremity of the basal article, but about half the distance of the inner margin of the basal article.

The type is in the United States National Museum (Cat. No. 54474). The cotype is in the Leyden Museum.

Genus TORADJIA Dollfus.

TORADJIA DOLLFUSI, new species.

Plate 1, fig. 2.

Body oval, contractile into a ball, 5½ mm.: 9 mm. Surface, smooth; color in alcohol mottled brown and yellow.

Head large, quadrangular, about twice as wide as long, 2 mm.: 1 mm. Epistome furnished with a high carina, narrow and sharp, which forms on the dorsal side of the head a sharp triangular projection between the produced ocular lobes. Dorsal surface of head smooth, not carinate. Antero-lateral angles of the ocular lobes not rounded. Eyes small, with about twelve ocelli. First pair of antennae minute, composed of two small articles. Second pair short, extending about two-thirds the length of the first thoracic segment; flagellum composed of two articles, the second about twice as long as the first.

The first segment of the thorax is large, about twice as long as any of the six following segments, and has the lateral parts extended and somewhat upcurved with the antero-lateral angles produced as far as the antero-lateral angles of the head. There is a very slight post-lateral fold into which the second segment fits. The three following segments have a thickening on the anterior part of the underside, very indistinct. The first two segments of the abdomen have the lateral parts covered by the last thoracic segment. The lateral parts of the three following segments are produced. The terminal segment is triangular, with the apex well rounded. The uropoda have the basal article large, extending as far as the post-lateral angles of the fifth abdominal segment and beyond the terminal segment. The inner branch is slightly longer than the outer branch, which is inserted on

the inner lateral margin of the basal article, about the middle, and both extend to the extremity of the basal article.

This species is larger than any of the other three known species of the genus described by Dollfus, being 9 mm. in length, while the other three are but 4, 5, and 6 mm. in length. It seems closer to *T. cephalica* Dollfus[2] than to the other two described by that author. From the figures of the three species shown by Dollfus, the head is carinate on the dorsal side, while in the species just described, the dorsal surface is perfectly smooth. *T. celebensis* and *T. gorgona* both have the body strongly tuberculate, while *T. cephalica* is slightly tuberculate anteriorly. *T. dollfusi* has the body perfectly smooth. Budde-Lund[3] mentions a fourth species of this genus, *T. conglobator*, which, in the short description he gives, he refers to it as having the epistome plain. He includes *Periscyphus weberi* Dollfus in this genus.

Eleven specimens of this species were collected at Nongkodjadjar, Java.

The type is in the United States National Museum (Cat. No. 54475). The cotype is in the Leyden Museum.

Genus PHILOSCIA Latreille.

PHILOSCIA JACOBSONI, new species.

Plate 2, fig. 3.

Body more than twice as long as wide, 7 mm. : 3 mm. Color in alcohol brown with irregular markings of a darker brown. Patches of dark brown on the sides of the segments with a light area on either side.

Head about twice as wide as long with the front rounded and not marginate. Eyes small. Antennae are long extending to the end of the fourth thoracic segment; flagellum composed of three articles, the first of which is one and a half times longer than the other two, which are subequal. First segment of thorax longer than any of the following, which are subequal. Seventh segment with the post-lateral angles acute and extending to the end of the fourth abdominal segment.

Abdomen abruptly narrower and deeply immersed in last thoracic segment. First two segments with the lateral parts concealed by the seventh thoracic segment. First five segments subequal in length. Terminal segment triangular with apex acute. Basal article of uropoda extending one-third of its length beyond the extremity of the abdomen. Exterior side canaliculate. Outer branch about twice as long as basal article. Inner branch extends about two-thirds the length of the outer branch.

Three specimens come from Semarang, Java.

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[2] Zool. Ergebnisse einer Reise in Niederländisch Ost-Indien, vol. 4, Heft 2, 1907, p. 367, pl. 13, fig. 2, text fig. 12*a*.

[3] Proc. Zool. Soc. London, 1902, vol. 2, p. 380.

The type is in the United States National Museum (Cat. No. 54476). The cotype is in the Leyden Museum.

PHILOSCIA JAVANENSIS, new species.

Plate 2, fig. 4.

Body smooth. Color in alcohol uniformly brown, with a somewhat mottled appearance of lighter and darker brown. On the terminal segment of the body are three elongated spots of the lighter brown, one in the middle and one on either side.

The head is about twice as wide as long, with the front not marginate and nearly straight. The eyes are small and situated at the antero-lateral angles, showing but very little in a dorsal view. The second pair of antennae have a flagellum composed of three subequal articles.

The segments of the thorax are subequal, with the exception of the first, which is a little longer than any of those following.

The abdomen is abruptly narrower than the thorax, but is not deeply submerged. The lateral angles of the last thoracic segment reach but little beyond the middle of the third abdominal segment. The first two segments are shorter than the three following, which are subequal in length. The terminal segment is more than twice as wide as long, with the apex very obtusely triangular. The uropods are short; the basal article extends but a short distance beyond the terminal segment with the exterior side canaliculate. The outer branch is about twice as long as the basal article; the inner branch extends to the middle of the outer one.

Two specimens come from Semarang, Java; another mutilated one is from Djocja, Java.

The type is in the United States National Museum (Cat. No. 54477). The cotype is in the Leyden Museum.

PHILOSCIA BUDDELUNDI, new species.

Plate 2, fig. 5.

Body oblong ovate. Color in alcohol, brown and yellow. Head and first thoracic segment with small areas of yellow, a larger area in the middle of the segment. The following six segments have the upper half of the segment yellow, the lower half brown with yellow spots. The first two segments of the abdomen are light, with a narrow transverse band of brown; the following three segments are dark with a light area on the upper half about the middle. The terminal segment and outer branch of the uropoda are light; the inner branch is lark.

The head is about twice as wide as long. The eyes are small. The antennae extend to about the end of the third thoracic segment. The flagellum is composed of three articles, the first being a little longer than the second, which in turn is a little longer than the third.

The first segment of the thorax is a little longer than those following which are subequal. The post-lateral angles of the seventh segment are obtuse and extend to about the middle of the third abdominal segment.

The abdomen is narrower than the thorax, with the sides of the first two segments covered by the last thoracic segment. The first five segments are subequal, the terminal segment being triangular with apex acute. The basal article of the uropoda extends half its length beyond the terminal abdominal segment, and is not canaliculate. The outer branch is twice as long as the basal article. The inner branch extends a little beyond the middle of the outer branch.

Four specimens come from Nongkodjadjar, Java.

The type is in the United States National Museum (Cat. No. 54478). The cotype is in the Leyden Museum.

Genus PORCELLIO Latreille.

PORCELLIO SUNDAICUS Dollfus.

Porcellio sundaicus Dollfus, Zool. Ergebnisse einer Reise in Niederländisch Ost-Indien, vol. 4, Heft 2, 1907, p. 372, pl. 14, fig. 17.

Locality.—Djocja, Java; one specimen.

PORCELLIO MODESTUS Dollfus.

Porcellio modestus Dollfus, Zool. Ergebnisse einer Reise in Niederländisch Ost-Indien, vol. 4, Heft 2, 1907, p. 373, pl. 14, fig. 19.

Localities.—Nongkodjadjar, Java, ten adult specimens and six immature; Djocja, Java, one specimen; Semarang, Java, one specimen; Gunung Gedeh, Java, nine specimens.

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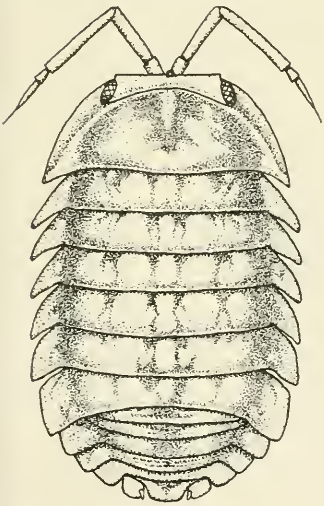
EXPLANATION OF PLATES.

PLATE 1.

FIG. 1. *Cubaris insularis*, new species (× about 8).
(*a*) Inner lateral margin of first and second thoracic segments showing coxopodites (enlarged).
2. *Toradjia dollfusi*, new species (× about 6).

PLATE 2.

FIG. 3. *Philoscia jacobsoni*, new species (× about 10).
4. *Philoscia javanensis*, new species (× about 14).
5. *Philoscia buddelundi*, new species (× about 20).



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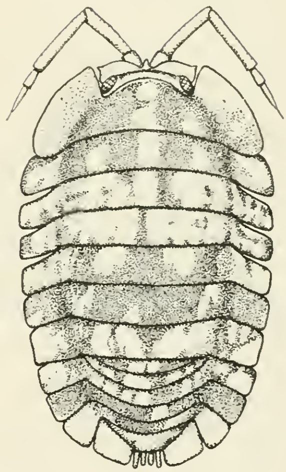
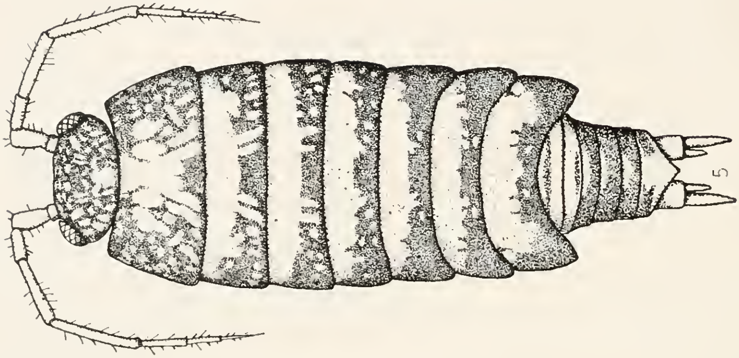


2

New Terrestrial Javan Isopods.

For explanation of plate see page 7.



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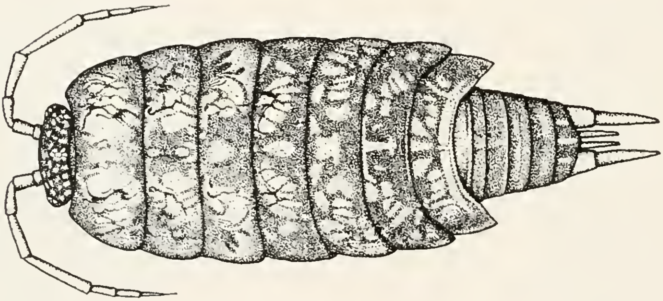

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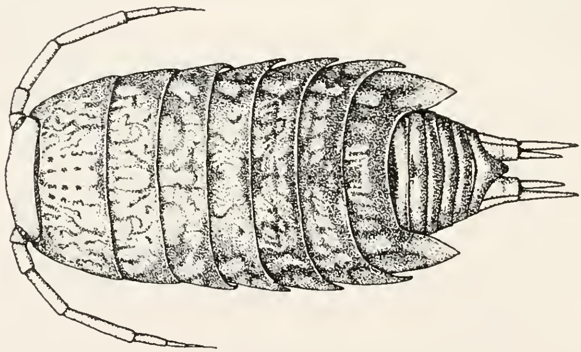

3

NEW TERRESTRIAL JAVAN ISOPODS.

FOR EXPLANATION OF PLATE SEE PAGE 7.

UNDESCRIBED SPECIES OF COSTA RICAN FLIES BELONGING TO THE FAMILY TIPULIDAE IN THE UNITED STATES NATIONAL MUSEUM.

By Charles P. Alexander,
Of the Illinois State Natural History Survey.

The following new species of crane-flies were included in an extensive collection of these insects taken by Señor A. Alfaro and sent to me for naming through the kindness of Dr. H. G. Dyar. The species of *Adelphomyia* extends the range of this interesting genus into the Neotropical Region. The new *Microtipula*, on the other hand, is the first species of this genus to be discovered north of Panama. The writer is indebted to Señor Alfaro and the authorities of the United States National Museum for the privilege of studying these very valuable collections. As indicated in the title, the types of all the novelties are preserved in the National Collection.

DICRANOMYIA PAMPOECILA, new species.

General coloration gray, variegated with dark brown; legs yellowish, the femora with a broad brown subterminal ring; wings subhyaline, reticulated with brown and brownish gray, this including conspicuous larger blotches at the wing-base, origin of *Rs*, at stigma and the end of vein R_{2+3}; vein *Sc* long.

Female.—Length 6 mm.; wing 6.6 mm.

Rostrum about one-half the length of the head, dark brownish black; palpi dark brown. Antennae with the basal segment dark brown; second scapal segment and basal segments of the flagellum brownish yellow, the distal flagellar segments passing into brown. Head brown.

Mesonotal praescutum broadly brownish gray medially with two small black dots near two-thirds the length of the sclerite; lateral margins of the praescutum reddish, behind near the suture with a ring-like black marking; scutum gray, each lobe with a darker ring-like mark; scutellum gray with two basal black spots; postnotum dark brown on the posterior two-thirds, the basal third silvery pruinose. Pleura light brown, gray pruinose, variegated with brown. Halteres short, yellowish, the knobs dark brown. Legs with the coxae gray pruinose, variegated with brown; trochanters yellow; femora brownish yellow with a broad subterminal brown ring; tibiae and tarsi pale

brown, the terminal tarsal segments darker brown. Wings subhyaline, conspicuously reticulated with brownish gray and brown; cell *Sc* more yellowish; conspicuous brown blotches at the base of the wing; origin of *Rs;* largest at the tip of R_1 (stigma), extending caudad to the fork of *Rs;* tip of R_{2+3}; paler blotches in cell *M* before midlength and in cell Cu_1; about a dozen narrow dark-brown reticulate markings in the costal cell, this coloration also including the costal vein; the blotch at the stigma sends four black rays to costa; the blotch at the top of R_{2+3} sends three rays to costa; conspicuous reticulations in all the cells, darker in the anterior region of the wing, paler in the posterior and anal cells; anal angle narrowly margined with brown; reticulations in the *2nd Anal* cell pale; costal, subcostal, and radial veins yellow, except in the darkened areas; remaining veins yellowish brown. Venation: *Sc* long, Sc_1 ending about opposite midlength of *Rs*, Sc_1 turned strongly into costa at the tip, Sc_2 a short distance from the tip of Sc_1, Sc_1 alone being about equal to *r-m; Rs* strongly angulated at origin; deflection of R_{4+5} about two-fifths of *Rs;* cell *1st* M_2 large, pentagonal, longer than any of the veins beyond it; *m* about one-third the outer deflection of M_3; basal deflection of Cu_1 before the fork of *M*, the distance about equal to *m;* Cu_2 shorter than the deflection of Cu_1.

Abdomen brownish testaceous.

Habitat.—Costa Rica.

Holotype.—Female, Tiribi, October 9, 1920 (A. Alfaro).

Type.—Cat. No. 24693, U.S.N.M.

DICRANOMYIA ALFAROI, new species.

General coloration light yellow; wings with cell *1st* M_2 open by the atrophy of the outer deflection of M_3; vein *Sc* long.

Male.—Length 3.2 mm.; wing 4.2 mm.

Rostrum and palpi testaceous yellow. Antennal scape yellow; flagellum broken. Head light yellow; eyes conspicuously black.

Thorax light yellow without markings. Halteres light yellow. Legs pale testaceous yellow; claws with a very long tooth at about one-third their length. Wings with a pale yellowish tinge; stigma barely indicated; veins pale. Venation: *Sc* long, Sc_1 extending to beyond midlength of *Rs*, Sc_2 near the tip of Sc_1; *Rs* long, gently arcuated; *r* at the tip of R_1; deflection of R_{4+5} about three-fifths *Rs;* cell *1st* M_2 open by the atrophy of the outer deflection of M_3; petiole of cell *2nd* M_2 shorter than the cell; basal deflection of Cu_1 beyond the fork of *M*, longer than Cu_2; *1st Anal* vein very weak; conspicuous macrotrichiae on the veins beyond the level of the origin of *Rs*.

Abdomen pale yellow.

Habitat.—Costa Rica.

Holotype.—Male, San José, October 7, 1920 (A. Alfaro).

Type.—Cat. No. 24694, U.S.N.M.

This interesting little *Dicranomyia* is very distinct from all other species known to the writer. It is named in honor of its collector, Señor A. Alfaro.

RHIPIDIA (RHIPIDIA) SUBCOSTALIS, new species.

General coloration obscure brownish yellow; mesonotal praescutum with three brown stripes; wings yellowish subhyaline with a heavy brown pattern along the costa; posterior and anal cells strongly brownish; anal angle and wing-tip subhyaline; vein *Sc* long, basal deflection of Cu_1 immediately beyond the fork of *M*.

Male.—Length 6.3 mm.; wing 7 mm.

Rostrum and palpi dark brown. Antennal scape dark brown, the flagellum broken. Eyes contiguous on the dorso-median line, the restricted vertex brown, light gray pruinose.

Mesonotal praescutum pale testaceous yellow with three brown stripes, the lateral stripes remote from the median stripe; scutum testaceous, the lobes brown; scutellum brown, paler basally; postnotum pale, conspicuously dark brown medially, narrowly split by a pale median line. Pleura injured by insect pests. Halteres dark brown, the base of the stem pale, the knobs large. Legs with the coxae and trochanters obscure yellow; remainder of the legs broken. Wings yellowish subhyaline with a very heavy brown pattern; a series of costal blotches, arranged as follows: At origin of wing; midlength of cell *Sc;* origin of *Rs;* tip of *Sc;* stigma and in the end of cell *2nd* R_1; the pale interspaces are very restricted; a brown wash includes most of cell *M*, excepting a blotch near the outer end; cell R_3 except three blotches of the ground color; most of the posterior and anal cells excepting a large area in cell *1st A* at the tip of vein *2nd A* and the conspicuous anal angle of the wing which are subhyaline; wing tip in cells *2nd* R_1, R_3, R_5, and *2nd* M_2 broadly and conspicuously pale; broad darker brown seams along the cord and outer end of cell *1st* M_2; veins brown, more yellowish in the subhyaline areas. Venation: *Sc* long, Sc_1 extending to about opposite two-thirds the length of *Rs;* Sc_2 at the tip of Sc_1 and about twice as long as Sc_1 alone; *Rs* long, gently arcuated at origin; inner end of the small cell *1st* M_2 gently arcuated, lying proximad of the inner end of cell R_5; *m* a little shorter than the outer deflection of M_3; basal deflection of Cu_1 just beyond the fork of *M*, about equal to Cu_2; *2nd Anal* vein bisinuous; longitudinal veins beyond the level of the origin of *Rs* with long macrotrichiae.

Abdominal tergites brown, the basal segments and hypopygium more yellowish; sternites obscure yellow. Hypopygium with the dorsal appendage a conspicuous hook, only slightly curved, the apex produced into a chitinized point.

Habitat.—Costa Rica.

Holotype.—Male, Tiribi, October 9, 1920 (A. Alfaro).

Type.—Cat. No. 24695, U.S.N.M.

RHIPIDIA (RHIPIDIA) LONGISPINA, new species.

Antennal flagellum with segments two to ten each with two pectinations; femora with a brown subterminal ring, terminal tarsal segments black; wings subhyaline, variegated with brown and gray, there being four brown costal blotches; basal deflection of Cu_1 before the fork of *M;* spines on the ventral pleural appendage of the male hypopygium very long and slender.

Male.—Length about 4.5 mm.; wing 5.8 mm.

The type is badly crushed.

Rostrum and palpi dark brown. Antennae dark brown, the pedicels of the flagellar segments somewhat paler; flagellar segments rather short, pectinate; first flagellar segment not pectinate, merely enlarged into a hemisphere whose proximal face is slightly produced; flagellar segments two to ten each, with two pectinations which become shorter on the terminal segments; flagellar segment eleven, without distinct pectinations, the inner face slightly produced; terminal segment simple, the apex prolonged into a slender point. Head dark brown.

General coloration of the thorax dark brown without clearly defined markings. Halteres brown. Legs with the coxae and trochanters dark brown; remainder of the legs pale testaceous brown, the femora with a brown subterminal ring, the tips narrowly obscure yellow; terminal tarsal segments black; claws with a single, conspicuous, basal spine. Wing-pattern somewhat suggestive of *R.* (*Arhipidia*) *domestica;* ground-coloration subhyaline; a series of four brown costal blotches, darker in cell *Sc*, the third at the origin of *Rs*, the last at *Sc;* the interspaces between the first three of these dark markings are narrower than the areas; stigma with a pale center; cord and outer end of cell *1st* M_2 seamed with gray; gray washes in the centers of all the cells beyond the cord with the exception of *1st* M_2*;* cubital and anal cells gray, sparsely variegated with subhyaline, the most conspicuous blotch being in cell *1st A* opposite the end of vein *2nd A*; axillary angle not conspicuously pale as in the *subcostalis* group; veins brown. Venation: *Sc* long, Sc_1 ending about opposite three-fifths the length of *Rs;* Sc_2 at tip of Sc_1*; Rs* long, arcuated at origin; deflection of R_{4+5} arcuated, a little less than one-third the length of *Rs; r–m* a little shorter than *r;* cell *1st* M_2 closed; *m* a little shorter than the deflection of M_3 and slightly arcuated; basal deflection of Cu_1 at about one-third its own length before the fork of *M*.

Abdomen dark brown, the sternites paler. Male hypopygium with the proximal face of the pleurite produced proximad and caudad into an obtuse lobe; ventral pleural appendage a fleshy lobe that is

much larger than the pleurite, the beak-like prolongation of the proximal face with two very long, slender spines that are practically as long as the prolongation itself.

Habitat.—Costa Rica.

Holotype.—Male, San José, November 12, 1920 (A. Alfaro).

Type.—Cat. No. 24696, U.S.N.M.

LIMNOPHILA DICTYOPTERA, new species.

General coloration dark brown; legs light yellow, the terminal tarsal segments darkened; wings creamy-white with a conspicuous reticulate brown pattern, larger blotches at the origin of Rs, at the stigma and near the outer end of cell R_2.

Female.—Length 9 mm.; wing 8.7 mm.

Rostrum and palpi dark brown. Antennae short, dark brown. Head brown, provided with numerous black bristles set in conspicuous dark setigerous punctures.

Mesonotum dark brown, very sparsely brown polinose, the praescutum with an indistinct capillary brown stripe. Pleura dark brown. Halteres brown. Legs with the coxae dark brown; trochanters yellowish brown; remainder of the legs light yellow, only the terminal tarsal segments dark brown. Wings creamy-white with a conspicuous dark brown reticulate pattern in all the cells, in cell Sc very reduced; larger brown blotches at the origin of Rs; a large oblique area extending from the stigma to the fork of M; another large area in the outer end of cell R_2 and the extreme tip of *2nd* R_1; numerous crossbars and other markings in the cells give to the wings a closely reticulated appearance; wing-tip in cells R_3, R_5 and M_1 broadly cream-color; anal angle of the wing in cell *2nd A* darkened; these dark crossbars include a series of about twenty-five in the costal cell; veins light brown, more yellowish in the pale areas. Venation: Sc_1 ending just beyond the fork of R_{2+3}, Sc_2 at the tip of Sc_1, and about twice the length of the latter; Rs long, strongly arcuated at origin; R_{2+3} shorter than the basal deflection of Cu_1; r some distance from the tip of R_1, the latter alone longer than the basal deflection of Cu_1; inner ends of cells R_3 and *1st* M_2 about in alignment; cell M_1 about as long as its petiole; cell *1st* M_2 elongate-rectangular; m about one-half the outer deflection of M_3; basal deflection of Cu_1 midlength of cell *1st* M_2.

Abdomen dark brown, the posterior margins of the sternites narrowly paler. Ovipositor with the valves long and slender, reddish horn-color.

Habitat.—Costa Rica.

Holotype.—Female, San José, October 6, 1920 (A. Alfaro).

Type.—Cat. No. 24697, U.S.N.M.

Limnophila dictyoptera is allied to *L. guttulatissima* Alexander, likewise from Costa Rica.

ADELPHOMYIA COSTARICENSIS, new species.

General coloration dark brown; wings brownish subhyaline, the stigma faintly darker; sparse macrotrichiae in cells *2nd* R_1 to *2nd* M_2; abdomen dark brown, the hypopygium yellowish testaceous.

Male.—Length 3.7 mm.; wing, 3.6 mm.

Rostrum and palpi dark brown. Antennae dark brown, 16-segmented, the verticils comparatively long; subterminal segments alternately long and shorter. Head dark brown.

Mesonotal praescutum dark brown anteriorly, paler behind with a darker brown median stripe; remainder of the mesonotum brown. Pleura yellowish testaceous, the anterior dorso-pleural region dark brown. Halteres pale, the knobs a little darker. Legs with the coxae yellowish testaceous; remainder of the legs pale brownish testaceous. Wings brownish subhyaline, the stigma faintly darker; veins brown. Sparse macrotrichiae in the ends of cells *2nd* R_1, R_2, R_3, R_5, and *2nd* M_2. Venation: Sc_1 a little longer than the basal deflection of Cu_1; r faint but evident, about its own length beyond the fork of R_{2+3}; inner end of cell R_5 arcuated; $r-m$ longer than the basal deflection of Cu_1; inner end of cell *1st* M_2 strongly narrowed, the basal deflection of M_{1+2} shorter than m; petiole of cell M_1 a little longer than the cell; m about twice the deflection of M_3; basal deflection of Cu_1 near midlength of cell *1st* M_2.

Abdomen dark brown, the hypopygium yellowish testaceous.

Habitat.—Costa Rica.

Holotype.—Male, Turrialba, August, 1920 (A. Alfaro).

Type.—Cat. No. 24698, U.S.N.M.

The discovery of a species of this genus in the Neotropical Region is of more than passing interest. Its nearest relative is *A. americana* Alexander of Northeastern North America from which it differs in the dark coloration and sparse macrotrichiae of the apical cells of the wings.

MICROTIPULA (MICROTIPULA) COSTARICENSIS, new species.

General coloration brown, the mesonotal praescutum with three darker brown stripes near the suture; nasus lacking; front yellow; dorsum of head brown; basal segments of antennal flagellum bicolorous; wings tinged with brown, the costal region strongly yellowish with alternate dark brown areas that include both the costal and subcostal cells, merging with the ground color in the radial cells; no macrotrichiae in cells of wings.

Female.—Length about 7.5 mm.; wing 8.8 mm.

Frontal prolongation of head short, clear yellow above, dark brown laterally and beneath; palpi dark brown; nasus entirely lacking. Antennae 12-segmented; scape yellow; basal four flagellar segments bicolorous, the basal two-thirds of each segment dark

brown, the terminal third yellow; terminal flagellar segments uniformly dark brown. Front and anterior part of vertex cream-yellow; remainder of dorsum of head brown.

Mesonotal praescutum pale brown, the usual stripes darker brown but indicated only near the suture, the median stripe bifid at anterior end; scutum testaceous, the lobes dark brown; scutellum testaceous; postnotum brown. Pleura brownish testaceous; a brown area on mesepisternum; mesosternum infuscated. Halteres brownish yellow, the knobs dark brown. Legs with the coxae and trochanters testaceous; remainder of legs brown, the femora paler basally. Wings with a brown tinge, variegated with yellow, dark brown and yellowish subhyaline; costal margin light yellow with four alternating blotches of dark brown, these including cells *C* and *Sc*, fading out posteriorly in cell *R;* the first brown area lies immediately beyond the level of the arculus; the third at origin of *Rs*, the second middistance between these last two; the fourth area occupies the end of cell *Sc*, confluent with the stigma; the yellow spaces between these brown areas are subcircular in outline; a conspicuous yellowish subhyaline area beyond the stigma in cells R_2 and R_3; a yellowish subhyaline area in the end of cell *M*, indistinctly connected with the last yellow costal area; the space behind vein *Cu* yellow; indistinct infuscations at base, midlength and apex of this yellow cubital area; the subhyaline areas elsewhere on wing-surface are very small, most evident in the ends of the posterior and 1st Anal cells; veins dark brown; no macrotrichiae in cells of wing. Venation: Sc_1 atrophied, Sc_2 ending before the fork of the long, straight *Rs;* tip of R_2 atrophied; petiole of cell M_1 longer than *m; m–cu* obliterated.

Abdomen brown, the basal tergites yellowish, the caudal margins of the tergites narrowly paler brown. Ovipositor with the valves horn-colored.

Habitat.—Costa Rica.

Holotype.—Female, Atirro, October 24, 1920 (A. Alfaro).

Type.—Cat. No. 24699, U.S.N.M.

Microtipula costaricensis differs notably from the only other described species of the subgenus, *M.* (*M.*) *amazonica* Alexander (Brazil-British Guiana), in the coloration of the body and wings. In its general appearance it agrees more closely with the subgenus *Eumicrotipula* Alexander in which the cells of the wing are densely provided with macrotrichiae.

DESCRIPTION OF A NEW SPECIES OF AGAMID LIZARD FROM THE MALAY PENINSULA.

By Doris M. Cochran,
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The species described below introduces apparently for the first time to the Malay Peninsula fauna a member of the group of the genus *Gonocephalus* represented by the type species *Gonocephalus chamaeleontinus.* This group, which is characterized by the supraciliary border being strongly raised and forming an angular projection posteriorly, has hitherto been known only from species occurring in Java, Borneo, Sumatra, and some of the adjacent smaller islands. The interesting point is that the new species seems to be more closely allied to the Bornean *Gonocephalus doriae* than to the Java-Sumatran *Gonocephalus chamaeleontinus.*

GONOCEPHALUS ABBOTTI, new species.

Diagnosis.—Supraciliary border strongly raised, forming an angular projection posteriorly; no enlarged scales on sides of back or on temporal region; scales of row next to median series of enlarged nuchal and dorsal crest-scales large, flat, without keel or spine; dorsal crest continuous with and lower than nuchal; third and fourth fingers of equal length.

Description.—Adult female, U.S.N.M. No. 24028; Trang, Lower Siam; Dr. W. L. Abbott, collector.

Head high, with strongly elevated supraciliary borders forming an angle posteriorly; snout as long as the diameter of orbit, ending in a pronounced rounded hump; no indication of supraorbital semicircles; scales between eyes and on snout only slightly smaller than those of supraorbital region; a few large, perfectly flat median scales on top of snout; tympanum smaller than eye-opening; sides of head covered with smooth scales about as large as the average dorsals; no enlarged scales on temples or body; 12 upper and 13 lower labials; gular sac well developed, with serrated anterior edge; gular scales much smaller than ventrals, smooth; body very strongly compressed; nuchal crest beginning on occiput; nuchal and dorsal crests perfectly continuous, gradually decreasing in height from above tympanum to the tail; no depression in the crest above shoulders; crest-scales smooth, triangular, nearly as wide as high, nuchals convex on front, concave behind; first (upper) row of scales covering base of crest composed of irregularly pentagonal flat scales as large

as those of the median row, without spine or keel; second and third basal rows smaller, smooth, polygonal; nuchal crest measured from lower edge of third basal row equals distance from orbit to halfway between nostril and tip of snout; dorsal scales small, smooth, not pointed, scarcely imbricate, without any appreciably enlarged ones; ventral scales much larger, smooth; limbs above with subequal smooth scales; third and fourth fingers equal; the adpressed hind limb reaches the orbit; tail without crest, strongly compressed, with keeled, slightly serrated upper edge; upper caudals smooth, lower ones larger and strongly keeled; length of tail not quite twice that head and body. Color (in alcohol) greenish above, with dark longitudinal reticulations; tail with regular dark annuli.

Dimensions.

Total length	360 mm.
Tip of snout to tympanum	34 mm.
Width of head	25 mm.
Tip of snout to anus	143 mm.
Fore limb	79 mm.
Hind limb	106 mm.
Tail	217 mm.

Remarks.—In comparing this specimen with adult females of *Gonocephalus chamaeleontinus* from Sumatra, I find that the latter differ from it in several striking characteristics:

1. The female *G. chamaeleontinus* has the dorsal and nuchal crests formed of comparatively long and sharply pointed lanceolate spines. The highest nuchal spines are about three times as high as their greatest width. The upper outline of the crest when viewed in profile shows a maximum elevation just back of the tympanum, with a sudden lowering in height above the shoulders, from which point the dorsal crest continues to decrease regularly in height. In the male *G. chamaeleontinus* there is a slight increase in the height of the dorsal crest for a few scales behind the depression, after which the dorsals decrease regularly. The crest of *G. abbotti* does not have any depression above the shoulders, but lessens gradually from above the tympanum to the tail. The first row of scales at the base of the median series forming the crest is mush larger in *G. abbotti*, being approximately of the same size as the median series of the crest. In *G. abbotti* these scales are flat, smooth, without keels or spines, while in *G. chamaeleontinus* they have a spine on the upper margin and are distinctly keeled.

2. The new species has no enlarged scales on the sides of the head. In *G. chamaeleontinus* the large conical scales above and below the tympanum are a prominent feature. There is a series of 8 or 9 enlarged tubercular scales on the sides of the body in *G. chamaeleontinus*. These are from three to six times the diameter of the sur-

rounding scales. In *G. abbotti* there are no enlarged scales on the sides, unless two or three slightly larger scales on the left side may be so interpreted.

3. In all the specimens of *G. chamaeleontinus* at hand there is a distinct trace of the supraorbital semicircle, appearing as a row of 4 slightly elevated scales. Between these two low ridges the scales are very small, almost granular. In *G. abbotti* there is not the slightest trace of supraorbital semicircles, and the scales of the interorbital region are not noticeably smaller than those elsewhere on top of the head.

4. In the new species the third and fourth fingers are of equal length, while in *G. chamaeleontinus* the fourth finger is slightly longer than the third.

In comparing *Gonocephalus abbotti* with *Gonocephalus doriae* Peters the resemblance is found to be much more close.

Thus the new species agrees with *G. doriae* in lacking the scattered enlarged scales on the back and the tubercles on the temporal region; in having the scales next to the nuchal and dorsal crest-spines large and flat, without keel or spine; and in having the third and fourth fingers of equal length, points which, as shown above, distinguish it from *G. chamaeleontinus*. On the other hand, it differs essentially from *G. doriae* in the dorsal crest, which, instead of being "almost as high as the nuchal," is *much lower and gradually diminishing from where it joins the nuchal.* The type and only specimen is a female, and the crests are probably not developed to the same extent as in the male, but judging from the differences between the males and females in *G. chamaeleontinus* the median spines of the crests probably never reach a development equaling that shown in the latter species.

The new species is named for its discoverer, Dr. W. L. Abbott.